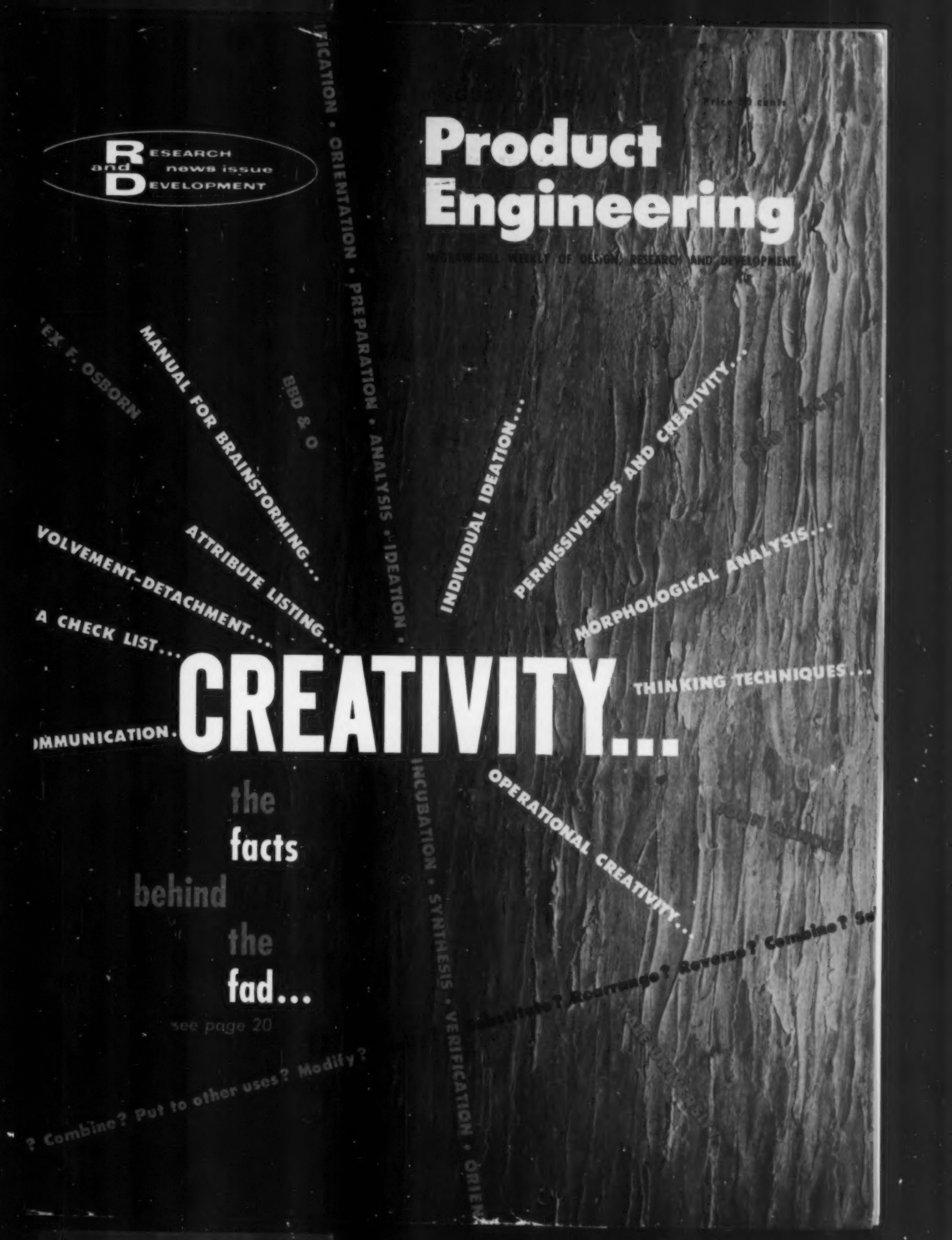
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the facts behind the fad...
see page 20
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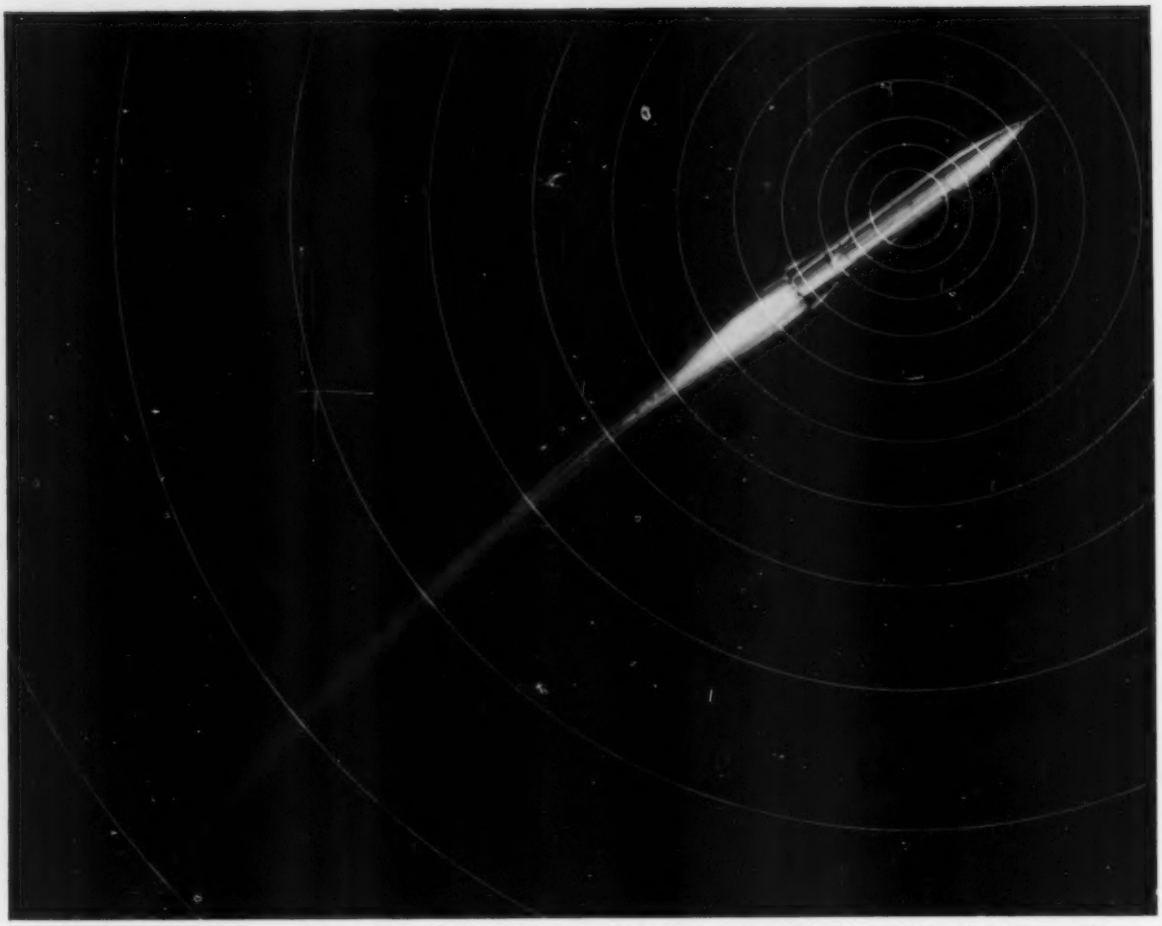

Things happen fast to a rocketing missile. High-nickel Mumetal shields help tape recorders get it all down accurately.

How Nickel helps record messages from space

When a missile rockets off into space, it detects all sorts of data – temperature, radiation, meteoric dust – the many things we need to know in order to conquer space.

Since radio transmission and reception between missile and ground is not always reliable, some missiles carry an airborne secretary–a multi-channeled tape recorder.

It records as many as thirty different bands of data side by side on a 1½-inch magnetic tape.

Confusion of all the magnetic fields crammed inside the tiny head could cause messages to come out garbled.

But there is a way to keep them straightened out–by using Mumetal* (77% Nickel). This alloy has the unusual ability of soaking up magnetic fields like a sponge. Thin, flat shields of Mumetal siphon off troublesome interference.

The manufacturer also covers the whole head with more Mumetal to bar stray magnetic fields on the outside from getting inside. And then a protective Nickel-chrome plating goes on top of that.

All in all, it's quite a job Nickel does. And something to keep in mind the next time you're faced with a problem in your product or process. If it has to do with high or low temperatures . . . magnetism . . . corrosion . . . fatigue or some other factor, write us. We'd be happy to show you how Nickel, or one of its alloys, may be able to help.

Tiny magnetic head of tape recorder has Mumetal shields to trap magnetic interference, help Davies Lab. Division of Minneapolis-Honeywell pack much in little space. Nickel-chrome plating on cover adds durability, corrosion resistance, and attractive appearance.

*Trademark, Allegheny Ludlum Steel Corporation

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the DESIGN issue

for August 31

FEATURING:

- **Latest development in spring-wrapped slip clutches**
  These clutches are simple—can even be home made—and are unaffected by temperature extremes or wear.
- **Three new epoxies join the pre-preg laminates**
  Combine good high-temperature performance with long shelf life for pre-impregnated glass stock.
- **Performance test of ball bearings**
  Check bearings for torque, vibration, and runout characteristics with these devices.
- **Operator comfort sets equipment vibration limits**
  Main guide to designing these blower wheels is amount of vibration that annoys people.
- **Shaft torque: charts find equivalent sections**
  Convert solid circular shafts to equivalent-strength hollow circular, elliptical, square, or rectangular sections.
- **8 snap-action devices**
  A further selection of basic arrangements for sudden motion after gradual force buildup.
- **Permanent-mold castings**
  Lowering the break-even point widens use of method.

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R and D RESEARCH and DEVELOPMENT news issue

August 24, 1959 Vol. 30 No. 34

DEPARTMENTS:

SIDELIGHTS 4
LETTERS 6
HORIZONS 19
SIGNIFICANT COMPONENTS 39
NEW LITERATURE 45
ADVERTISERS' INDEX 45
FYI PERSONAL 46
WHY NOT R & D? 47
PUBLISHER'S POSTSCRIPT 48

FEATURED:

CREATIVITY . . . THE FACTS BEHIND THE FAD. How to find the creative man and how to measure, control, and inspire him 20

COOPERATIVE RESEARCH. Competing companies join forces to develop new ideas 27

TRENDS IN APPEARANCE DESIGN. A magnetic tape recorder redesigned for appearance and convenience. A revolutionary dump truck . . . 36

FIELDS OF INTEREST:

MATERIALS:
Thin, metallic film properties may be radically different 8
Brittle materials—what makes them that way? 14
Tough new fiber makes its debut 14

PROCESSES:
Powder metallurgy finds new places in design 27
Heat-treated nickel-plated Ti prevents gear galling 31

ELECTRICAL:
Electroluminescent panels may be used as switches, relays, and amplifiers . . . 7
New crystals for electronic jobs 13
Tiny computer elements increase speed, reduce cost 32

DESIGN:
New engine design "burns anything," runs noiselessly 7
Three new valves from Britain 8
Mercury valve for gases controlled by solenoid 13
Plastics applications—the possibilities multiply 14

TEST:
"Solid" gas used in thickness gages, nuclear batteries 7
Liquid density measured by vibration of unbalanced rotor 8
Gas thermal conductivity measured at high temperature 13

GOVERNMENT:
Cancel $110-million design contract for chemical-fuel engine 11
Taxation on interstate commerce under attack 31

PERSONNEL:
Technical manpower resources included in 1960 census 33
Executive-development correspondence course offered by military 34

Product Engineering ..... SIDELIGHTS

R and D Research and Development news issue

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● "Twas brillig, and the slithy toves . . ." Lewis Carroll's lilting stanzas were the real inspiration for this week's cover. But our words were not made up for the occasion. They were collected during a brief scan of a report called, "Individual Creativity and the Corporation" to be reviewed in these pages shortly. The creativity fad (p 20), as all fads do, swept in a whole new dictionary of beautiful words. Bother the meanings! Aren't they lovely to listen to, and say?

● **Two appearance design stories** came out of Detroit last month. General Motors invited 35 newspaperwomen to "be a designer for a day and see what improvements you would make in our automobiles." The ladies made some very practical suggestions: snap-on slip covers which would feel cool in the summer, could be changed to warmer colors and textures in winter; clip-top ashtrays that children can't open; a shelf for purses somewhere near the driver's seat; a rosy-gold beige paint, slightly irridescent, which wouldn't show dust. One week later Montgomery Ferar, a noted industrial designer, was quoted, "Detroit is becoming the research center of the world . . . Detroit has more talent in the creative field than any place else in the world." We see where they get it.

● **Talking about brainstorming for ideas,** Dr. Guy Suits of General Electric offers the following calculation: "Suppose we have 10 participants each capable of $\frac{1}{10}$ of an idea per minute. How long does it take to combine their partial ideas in the right sequence to produce a full idea? The time required is $n^n t$ where n is the number of participants, each of whom has $1/n$ random ideas in t units of time. For the case in point, it will take 20,000 years to produce a full idea! Interestingly enough, there will be several million half-ideas (or half-baked ideas)."

ABP August 24, 1959

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Manufacturer: Scranton Cellomatic Corporation, Archbald, Pa. Molder: Peerless Plastics, Culver City, California.

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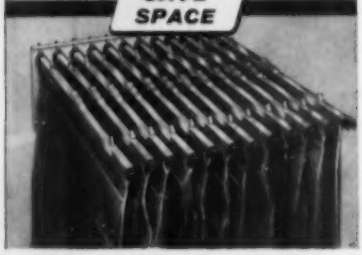

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Reader To Editor...

Quantity Isn't Everything

To the Editor:

I noted that when your magazine circulated through the company, the "Tangent" editorial in the issue of Mar 16 was marked as reading for everyone. (The article in question dealt with Soviet production capacity—Ed.) I was particularly interested in your statement that we should be giving more consideration to our long-term goals and then determine what our short-term objective should be, based upon this consideration.

One point does worry me. This is the fact that people continually place quantity of industrial output and quantity of engineers above the need or the requirements which were placed before the needs of any country. It is relatively unimportant how many engineers Russia has, or how many missiles they shoot, or how many tractors they make if it is only to be used as the measuring stick for our success or failure. The number of missiles we shoot, the number of engineers we graduate, etc., should be dictated by the basis of our needs. These needs can only be determined by investigation of what we want to accomplish and what we want to do.

—R S. Naegele
Dow Corning Corp
Midland, Mich.

Spring Steel Fastener

To the Editor:

We feel that reference to one or more products of our manufacture should have been made in your article, "Assembly Methods" (June 8, p 91). Under "spring steel fasteners simplify assembly" our self-threading PALNUTS could very well have supplied information of more than average interest and value to readers.

—E L Johnson
The Palnut Co, Mountainside, NJ

Voice From the Wilderness

To the Editor:

"Our Mile-long Economy" (PE—Aug. 3, p. 37) may be questioned by many "loose" thinkers. However, don't worry needlessly about it because like inflation, it is a product of this big money age we live in, a wolf in sheep's clothing.

As always, inventiveness, when it is truly genuine, resembles a Boy Scout lighting a camp fire Indian style. First a tiny spark fanned into a newborn flame—a flame easily snuffed out by alien forces but potentially a vigorous self-sustaining flame, not easily extinguished. But I ask you, why be inventive and risk being branded a heretic? Why throw a helpless idea out into a cold cruel world of "immutable" laws and proven facts?

Rather, leechlike, attach yourself to a group of blowhards who have access to a few hundred million dollars of government appropriations and vociferously propose a readily digestible, non-ingenious "new" idea such as the two-mile long tube or the "horse and buggy" space cruiser. After all, if they don't work we will have learned something, won't we? Yes, even if it's what not to build with next year's appropriations.

Thus it is that in an age of true scientific awakening, government has been sold a bill of goods by the heavy spenders who, with fat contracts to numb their ingenuity, regress into the old and well-worn trial and error rut. Brute force and rugged determinism in the form of multibillion dollar expenditures replace cold hard thinking and tight pocketbooks. "Necessity is the mother . . . ." —Walter H. Trask
Chicago

English Flowmeter

To the Editor:

We were interested to read in your Research and Development issue of June 15, p 56, a request by R. A. Neilson for a flowmeter for milk. We have been preparing a flowmeter for the milk industry, which is now undergoing acceptance trials in a dairy and at the National Institute for Research in Dairying. This flowmeter

meets all the requirements specified by Mr. Neilson with regard to accuracy, ease of cleaning and non contamination of milk.

—F. Jackson
Integral Ltd.
Wolverhampton, Eng.

Who Writes the Ads?

To the Editor:

After reading with interest your column "Tangents" in the June 22 issue regarding men with journalism degrees who cannot spell, I turned to page 151 to read an ad for an assistant manager with ". . . strong background in design of relays, accurators, etc. . . ." What are "accurators"? Are your advertisements written by "journalists"? —Peter Valenti
Chief Gear Engineer
Sargent Engineering Corp
Huntington Park, Calif

• We'd like to think so.—Ed.

DEVELOPMENTS TO WATCH...

American

A gas goes "solid" . . .

. . . as Tracerlab, Inc, finds a way to "trap" the versatile krypton 85 radioisotope (*PE*—May 12 '58, p 72) for use in thickness gages, air-pollution control equipment, nuclear batteries and other devices.

The trapping system is an application of clathrates or "molecular sieves" (*PE*—June 2 '58, p 11) in which the gas is actually caught and held within the molecular structure of a complex crystal (in this case, hydroquinone). This way, says Tracerlab, more than 30 times as much krypton can be incorporated in a given volume—and it will be permanently and safely held unless deliberately released by heating or chemical dissolution of the clathrate.

First application is in an experimental air-pollution monitor in which the clathrate containing krypton 85 is placed in a glass tube, through which air to be analyzed is drawn. Contaminating material reacts with the clathrate, releasing krypton 85 in an amount proportional to the amount of contamination. A radioactivity counter does the rest.

Electroluminescent panels that respond . . .

. . . to both ac and dc excitation may provide a new route to switching, relaying, audio and dc amplification, and on-off indication, say W. A. Thornton and H. F. Ivey of Westinghouse Lamp Div.

When ac and dc voltages are applied simultaneously to an electroluminescent panel, they point out, a strong interaction occurs which results in a light output level considerably above that which can be achieved by either type of excitation alone. Furthermore, if the primary voltage is dc, addition of a small ac voltage can produce a strong enough reaction to permit an electroluminescent panel to serve as an on-off indication; or, in conjunction with a photosensitive device (a phototube or a two-dimensional photoconductive electroluminescent system) as a voltage or power amplifier. Such a system, being the solid-state equivalent of multi-pole and multi-coil relays, might also be used for switching or relaying purposes.

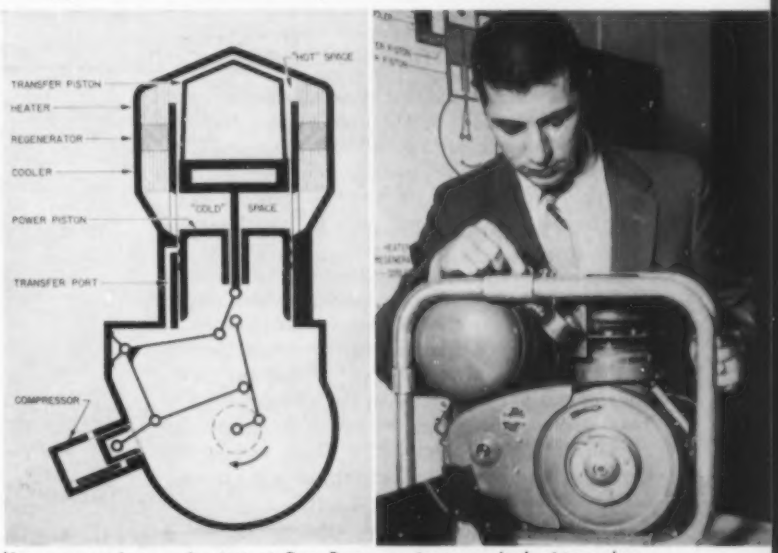
(Note: For background information on electroluminescence and its applications, see *PE*—Sep 15 '58, p 74).

An engine that "burns anything," runs noiselessly at constant speed...

. . . and has no internal-combustion fouling problems is under test at Esso Research & Engineering. The engine itself is a Stirling-cycle unit developed by Philips of Eindhoven, Holland, as part of its long-term research program on hot-gas engines (*PE*—July 20, p 19); but Esso has a number of ideas on how this one can be improved and applied.

Because it operates at constant speed, regardless of load, Esso engineers believe the machine should be especially useful for products like lawn mowers, and for heat pumps, compressors, and portable generators.

Essentially, the engine consists of a cylinder with 2 pistons between which gas (air, helium, or hydrogen) is trapped (see diagram). The engine can be connected to any power-takeoff system; or, if desired, the engine can be connected in reverse—as a driven rather than a driving mechanism—and used as a refrigeration source. —ARG



Hot gas engine, under test at Esso Research, features dual pistons, has heating and cooling chambers outside cylinder. Upper piston moves gas back and forth so it is alternately heated and cooled; lower piston is operating component, driven by gas as it expands.

DEVELOPMENTS TO WATCH...

World-wide

Properties of thin metal films may differ radically . . .

. . . from those of materials in solid form, German and French researchers report, confirming and extending work already being done in this country. Investigations are bringing findings like these:

• Vapor-deposited and electrodeposited cobalt, nickel, and iron coatings lose their ferromagnetism completely as film thickness drops below 20 angstroms, says a German report.

• The temperature at which thin films are deposited—the temperature of the substrate, that is—may be critical in determining subsequent performance of the film itself. Films vacuum-deposited on glass at 330 F are "10-15 times less resistant initially" than those deposited at room temperature.

• Thermoelectric power is also affected by film thickness and deposition temperature, but the thermoelectric effect first increases to a maximum as film thickness is decreased; then drops off again after a certain point is reached. The exact maximum depends on whether the coating was deposited on a hot or cold base.

Analytical abstracts of these reports are available from Cobalt Information Center, Columbus 1, Ohio. Abstract numbers are 3-07, 3-08, and 3-13.

Three valves of novel design . . .

. . . are among the intriguing components being developed by United Kingdom Atomic Energy Authority engineers:

One is a 4π non-return unit for gases, described as having a porous-walled inner chamber submerged in mercury. A passage leading from the inner chamber to the outside serves as gas inlet. Because the gas can bubble out through the mercury, but the mercury cannot get into the chamber, the unit achieves its non-return action.

The second is a valve with a protected sealing ring. Only a minimum amount of information has thus far been released on this one, but the UKAEA says: ". . . In this unit, the valve member has two parts, one covering the valve seat whilst the valve is open, the other closing the valve. Means are provided for presenting either part to the valve seat."

The third is a needle valve, designed to prevent damage to the needle by excessive pressure, yet permit complete closure of the valve by seating the needle itself with a biased spring.

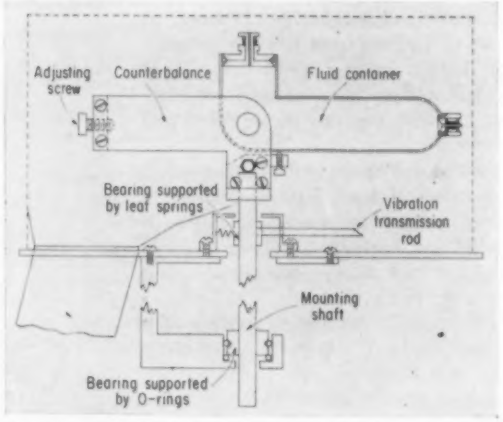
Information on the present status of these developments may be obtained from Patents Exploitation Officer, UKAEA, 11 Charles II St, London, SW 1.

New way to measure liquid density . . .

. . . uses vibrations produced by an unbalanced rotor. G. J. Thiessen and I. R. Dagg of Canada's National Research Council, say the method is adaptable to continuous control of homogeneous liquids, and may hold promise even for non-homogeneous materials (suspensions of wood pulp in water, for instance).

Basically, the equipment consists of an L-shaped container, mounted on a vertical shaft which can be rotated (see diagram). The container is so designed that some liquid will remain in the vertical portion of the container during rotation, so that any excess volume will not contribute to the off-balance vibration. Because the heavier the liquid, the greater the vibration, vibration becomes a direct measure of density, a flexibly mounted bearing serves as a mounting transmission and pickup device.

The unit diagrammed is for batch-testing, but a continuous flow unit is being designed and Thiessen and Dagg believe it will be accurate to one part in 20,000 when applied to essentially homogeneous materials like oils. —ARG

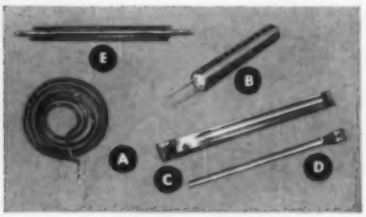


Simplest model of densimeter is a batch-type unit for both homogeneous and non-homogeneous liquids. Driving mechanism is a synchronous motor, chosen for minimum variation of torque with armature position. Entire unit is mounted on a heavy cement block.

How to choose electric heaters of the right type and size for your design

Here is condensed information to help you get the most economical electric heater for your surface heating design problem.

Two factors generally determine which type heater should be used for any particular surface-heating application. They are: the physical characteristics of your product, and the surface temperature required.



General Electric *tubular heaters* (a) can be formed to unusual shapes and may be "cast in metal" as part of your product during manufacture. They may also be located in grooves, inserted into drilled holes, immersed in liquids, wrapped tightly around the surface or spaced away.

G-E *cartridge heaters* (b) are ideal for "spot" heating of small areas. Short and compact, they can be easily inserted into drilled holes within the machine or surface.

For flat metallic surfaces, such as hot plates, platens and dies, *strip heaters* (c) may be clamped on or spaced away. General Electric *insertion heaters* (d) are ideal for heating hollow bolts for high-pressure steam-shell joints to prevent steam leakage.

For warming tables, and preheating plates, G-E *vane heaters* (e) may be clamped on or spaced away.

To figure the amount of heat required for your application:

1. Find the volume in cubic inches of the material in process.
2. Figure needed temperature rise in degrees F (subtract initial temperature of material from desired final temperature).
3. Find heat absorbed by material (Table 1 applies to all materials except those listed in Table 2). Values from Table 2 should be added or subtracted from values in Table 1 to correct it.
4. Determine the total surface area of the platen.
5. Using this area and the desired final temperature, check Table 3 to get heat losses of platen.
6. Add kilowatts computed in Step 3 to those computed in Step 5. You now know how much heat is required.

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TABLE 1—HEAT ABSORPTION IN KILOWATTS OF MATERIAL IN PROCESS

Volume of Material in Process (cu. in.)	Temperature Rise in °F 50	100	150	200	250	300
1	.006	.012	.018	.024	.030	.036
5	.030	.060	.090	.120	.150	.180
25	.090	.180	.270	.360	.450	.540
100	.360	.720	1.08	1.44	1.80	2.16
500	1.80	3.60	5.40	7.20	9.00	10.8
1000	3.60	7.20	10.8	14.4	18.0	21.6

TABLE 2 CORRECTION FACTOR

Material in Process	Subtract or Add % as indicated to figure in Table 3
Aluminum Dry	−30%
Wood or Paper Wet	−50%
Wood or Paper	+20%
Glass	−40%
Rubber	−30%

This table is based on a ten minute working cycle. If working cycle is other than 10 minutes use following formula to correct values: 10 divided by the number of minutes in the cycle times the kilowatts given above equals the kilowatts at the new cycle. Table 1 will apply for all materials except for those listed in Table 2. Apply correction factor if needed.

TABLE 3*—PLATEN HEAT LOSSES IN KILOWATTS

Surface area of metal platens in sq. inches	Final temperature in degrees F of metal platens 100	200	300	400
100	.024	.080	.160	.280
250	.060	.200	.400	.700
500	.120	.400	.800	1.40
1000	.240	.800	1.60	2.80
2000	.480	1.60	3.20	5.60
3000	.720	2.40	4.80	8.40

*This table based on platens being completely uninsulated.

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DEVELOPMENTS TO WATCH...

Washington

An ax hovers over Pentagon . . .

budgets once again. The result will be what Defense Secy McElroy calls "rugged decisions" cutting or killing projects to develop new planes, missiles and other military hardware.

First evidence came recently when the Pentagon cancelled its program to develop "exotic" high energy fuels and the engines to burn them, after spending $110 million on these projects. (PE—Jul 27, p 10).

The chemical fuels and a special J93-5 engine, under development at General Electric, were slated to go into the Air Force's B-70 bomber. The plan was to inject boron-base fuels into the engine's afterburners to give extra range at top speeds. Residue from the fuel prevented using it directly in the engine.

Now, the Air Force will use the J93-3 engine that is being developed for the F-108 interceptor for the B-70 also. This engine is conventional jet. It will give the bomber Mach 3 speeds with standard jet fuels and no special afterburners.

Behind the economy drive is President Eisenhower's desire to mark his last year in office with a respectable budget surplus. In line with this goal, the Pentagon has been ordered to hold spending in fiscal 1961 (beginning next July 1) to the $41 billion total estimated for this year. Work on fiscal 1961 budgets has just begun.

As major development projects shape up now, a big spurt in military expenditures seems inevitable. Projects such as the Air Force's Minuteman, ICBM, the Dyna-soar Orbital Spacecraft are among those projects at the crucial point where large increases in funds will be needed next year to advance from the design stage to fabrication of hardware.

The Defense Dept will be unable to bring such projects along as fast as scheduled, and at the same time hold to the $41-billion expenditure level while producing Atlas, Titan, and Polaris missiles and other costly equipment at rates now planned for fiscal 1961.

Latest development is cancellation by Navy of its $38-million fuel contract with Callery Chemical.

Generals won't lose their jobs . . .

and the Congressional flip over retired military brass going to work for defense contractors is unlikely to result in any important new restrictions. Present laws forbid the ex-brass to "sell". But most retired officers are hired for technical consulting, not direct sales work.

Some Congressmen are pushing for new restrictions to spell out what "selling" constitutes and to bar the brass from firms with projects for which they were "directly responsible" while on active duty.

But such new curbs—even if enacted—are not likely to depress the trend of retired military to industry. Industry needs their skills and background to develop and design new military hardware; most of the ex-brass are young and willing to work even though military rules force them out of uniform.

Air Force switch on weapons system . . .

is taking back some responsibility delegated to prime contractors in an effort to centralize control over development under the "Weapon System Management" concept.

Behind the shift in policy are Congressional charges that Air Force contracting officers have "abdicated" control over major research and development projects to prime contractors and that the greater centralization of management has 'stifled" competition for design and development work on subsystems and components.

The Air Force now plans to (1) freeze design configurations and to contract directly with subsystem makers; to (2) "break out" standard equipment—motors, generators, and the like—from an aircraft, missile or other weapon system project for open competition when volume output of the end-product is okayed; and to (3) conduct separate design competition for major subsystems.

Still another measure is the Air Force's decision to pick and choose among teams of companies which combine for a joint bid proposal on new R & D projects. Up to now, the Air Force has in most cases awarded a prime contract to the manager of the winning joint venture, and associate primes or subcontracts to the companies working on the subsystems or important components.

Example of the new policy is the XGAM-87A long-range, air-to-surface missile. Douglas Aircraft won a design study contract. GE which was a member of Douglas' team during the prime contract competition for the guidance subsystem was passed by. The Air Force has now ordered Douglas to hold open competition for a guidance subcontractor.

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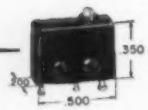

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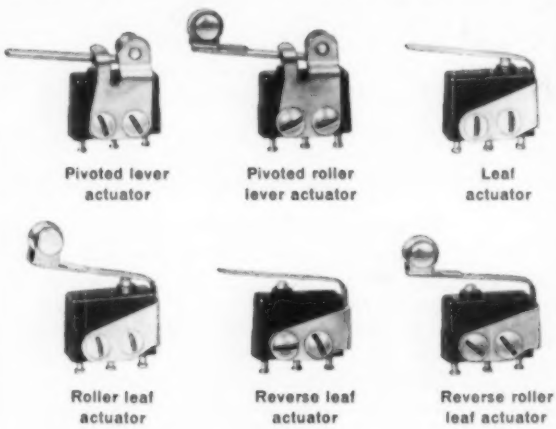

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WHAT'S HAPPENING IN... Science

New crystals for electronic jobs

Several new ferroelectric and antiferroelectric materials that hold promise for electromechanical transducers, magnetic amplifiers, and information-storage devices, have been discovered at Penn State.

Reporting to the American Crystallographic Society on studies of sulfate-selenate-fluoberyllate systems, R. Pepinsky, K. Vedam, and Y. Okaya described more than a dozen new materials.

Among the most promising is a lithium selenate. It's a stable compound that grows easily in very large crystals, and has "extraordinarily high spontaneous polarization."

The lithium compound is believed to be the first material of its type not containing ammonium or substituted-ammonium ions. However, several ammonium compounds have also been prepared and have considerable interest. A sodium selenate, ferroelectric below room temperature; and a cesium selenate, apparently anti-ferroelectric, are also under study.

Novel approach to high-temp measurement

A furnace cooled by boiling water and a conductivity cell made of platinum are helping MIT engineers measure thermal conductivity of gases at temperatures above 930 F.

The furnace is a porcelain cylinder (about 1 in. dia and 12 in. long) wound with platinum ribbon and surrounded by a double-walled brass case. Magnesia and asbestos fill the space between the cylinder and the interior brass wall to provide insulation; but as added protection, space between the walls is filled with water that boils when the furnace gets hot and so holds the surrounding temperature constant at the boiling point.

The conductivity cell consists of an emitter cylinder (of platinum) containing a heater element of fine platinum wire wound on a porcelain mandrel and two cylindrical "heat stations" for the gas whose conductivity is to be measured. This 3-section unit is inserted in a platinum "receiver" cylinder and separated from it by ceramic spacers. Thermocouples are welded to the outside of the receiver. The whole assembly is then placed in a nickel-sheathed quartz tube connected to the gas supply.

With this setup, say MIT researchers, it is possible to maintain a specified temperature in the 400- to 1600-F range for periods of an hour or more, and to hold temperature variation to a few thousandths of a degree for shorter periods of time.

briefs . . .

Thermomagnetic power offers little hope, from an efficiency standpoint at least. Confirming preliminary research results (*PE—June 8, p 34*), the Navy's final report on the efficiency of thermomagnetic energy conversion systems takes a rather dim view of their future. A thermomagnetic generator was built and operated; but the amount of energy that must be supplied to overcome the large Weiss field and take advantage of the current generated as a ferromagnetic material of this type passes its ferromagnetic transition temperature is almost equal to the maximum magnetic energy in the working substance. The final NRL report, #5328, will be available in about 6 weeks from OTS, Dept of Commerce, Washington 25, DC, as PB 151736.

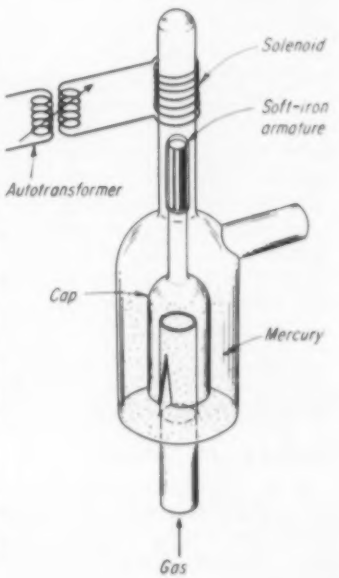
Slide calculator that packs a tremendous amount of information about the chemical elements on a 4½- by 10-in. slide has been developed at U of Ill, will be made available commercially by Graphic Educators, 633 S Plymouth Court, Chicago 5, Ill. For each element, it gives valence, melting point, density, atomic weight, isotopes, oxidation and ionization potential, numerous other factors. Price, complete with instruction booklet, is $3.25. Also newly available from the company, a radioactivity decay-rate circular slide calculator priced at $10.

—ARG

Magnetism turns it off

To combine the advantages of mercury high-vacuum valves (notably, prevention of gas leakage) with precise control of valving action, Naval Research Lab designed the cutoff unit pictured here. Basic element of the unit is the glass cap which covers the main gas line. It is lifted and replaced magnetically, and the unit is so designed that it can be controlled through an auto-transformer, from a remote location.

The V-slit in the cap, and the fact that the cap can be raised and lowered gradually, makes it possible to vary the aperture at will.



Mercury cutoff valve controls gas flow by means of a solenoid-operated cap that fits over main gas line. Mercury, in valve body, seals against leakage.

WHAT'S HAPPENING IN... Materials

Why so brittle?

What makes some metals so very hard to fabricate, while others—closely related—pose little or no problem? A study by Battelle Memorial Institute of six metals in groups 5A and 6A of the periodic table of elements provides several clues: Of the two groups, those in the first—tantalum, columbium, and vanadium—show ductile-brittle transformation points well below room temperature or have no clearly defined transition point at all; while those in the second—chromium, molybdenum, and tungsten—have transition points near or well above room temperature.

On the other hand, the first three are markedly embrittled by hydrogen, while the second group is not.

When it comes to other embrittling impurities—carbon, oxygen, and nitrogen—the picture is spotty. The effect of these elements on the transition temperature and on ductility at room temperature has not been fully investigated. Vanadium seems at least moderately affected by both oxygen and nitrogen. Chromium is severely affected by carbon and nitrogen. Molybdenum's bugaboo seems to be oxygen. In general, Battelle metallurgists draw these conclusions:

- Embrittlement temperature is affected by recrystallization, grain size, interstitial content, and strain rate.
- The transition from ductile to brittle behavior is associated with a rapid rise in yield strength as the transition temperature is reduced.
- Fracture test results are markedly influenced by testing methods, with torsion tests giving the lowest transition temperatures and impact and notched bend the highest.

Tough new fiber makes its debut

A new synthetic fiber offering high strength and heat resistance is being introduced by North American Rayon Corp. Named *Vycron*, it's a polyester fiber that falls in the same general class as DuPont's *Dacron* and Eastman's *Kodel*. But, says North American, it differs from other polyesters in "total chemical constitution and basic structure."

Vycron's breaking strength (5.6 gm/den) is a little below that of Dacron, but slightly higher than Orlon. Breaking elongation is quite high—35% as compared with 19% for Dacron, 26% for nylon and 16% for Orlon. The new fiber stands temperatures at least to 300 F; and, the company says, shows low moisture absorption.

Applications for the new fiber are now being explored.

Where to use the new plastics

Polypropylene and polycarbonate resins (*PE—Sep 29 '58, p 36*) are still so new that reports from users both here and abroad are worth culling.

Describing recent developments in West Germany, Dr Karl Mienes, consultant to Foster Grant Co, Leominster, Mass, says:

"The importance of polycarbonate is partly due to its excellent form stability, arising from its remarkably high transition point; its most unusual impact strength; and a sharply increasing tensile curve with small changes in elongation. It seems very well suited for non-creeping structural parts." Among the possibilities: gears, coil forms, cams, lenses. However, polycarbonates are sensitive to caustic and steam.

Polypropylene, on the other hand, shows excellent resistance to hot water and might well challenge nylon for such applications as washing-machine parts. But it is not as oxidation-resistant as polycarbonate at elevated temperatures.

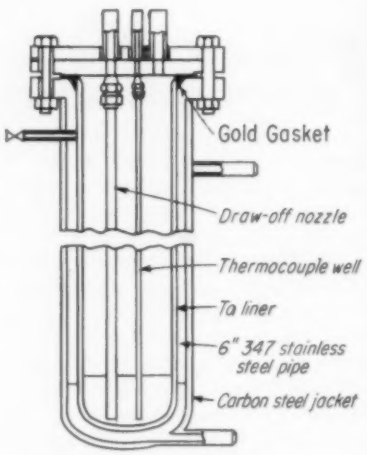
He notes, too, that the strength of polypropylene film at 212 F is "as high as film of branched ('normal') polyethylene at room temperature."

In this country, Phalo Plastics Corp, which has recently begun production of polypropylene-insulated wire, welcomes the strength hardness, crush resistance, and heat resistance of the newer material as compared to polyethylene.

But Phalo also notes that polypropylene stiffens and may become brittle at zero F, and its strength and insulation toughness depend very largely on the condition of its outer surface. "Once this tough surface is scored or circled with a sharp edge," says Phalo, "the high tensile strength is lost." This would, however, be an advantage in machine cutting and stripping.

brief . . .

High-purity gold to meet the growing need for this precious metal in industrial products and research (*PE—Aug 10, p 13*) is being produced for sale by Asarco at its Central Research Lab, Plainfield, NJ. Containing less than 10 ppm of such impurities as copper, silver, and palladium, the metal is priced at $50 a troy oz.
—ARG



Typical of gold's new jobs is this one, in a tank for processing highly corrosive nuclear reactor byproducts, where it works with many other new and exotic metals. Gold is used only for the tiny gasket at the top; but it does a vital job there.

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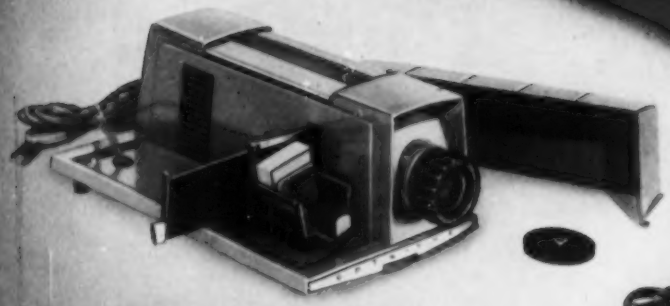

This is the semi-automatic model of the Opta-Matic projector, using a 300-watt bulb and 4-inch f3.5 Optacor coated projection lens. With this new lightweight, unbreakable, heat-resistant MARLEX case, the whole unit weighs only slightly more than 5 lb. The special "Riviera Blue" color of the case is molded into the MARLEX . . . will never fade or discolor. And the attractive textured finish is resistant to marring and stains.

This fully automatic model of the projector can be operated either with the push buttons on the motor or the remote control cord, or with a built-in 8-second timer. The removable section of the black textured finish MARLEX housing snaps into place making a neat, fully enclosed unit, easily carried by the disappearing handle. MARLEX was also specified for the height adjustment knob on these projectors. MARLEX is excellent for these precision molded components, having superior toughness, abrasion-resistance and self-lubricating qualities.

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"Our new Opta-Matic is the first projector on the market with a thermoplastic housing. Since this was a design innovation, we had to be sure to select a suitable resin, so we tested them all. One 'high-impact' plastic lasted just 4 hours in our heat test before it melted! Another 'heat-resistant' plastic cracked in several places in our drop test. MARLEX was the only material tested that matched all our specifications and passed all our tests. In fact, we advertise a lifetime guarantee for all MARLEX projector components!"

Whether your major interest is designing with injection moldings, thermo-formings, extrusions, filaments, sheet or transparent film, you will find that MARLEX is the best thermoplastic resin for the job. In fact, no other material serves so well, and so economically in so many different applications. How can MARLEX serve you?

*MARLEX is a trademark for Phillips family of olefin polymers.

These beautifully styled Opta-Matic projectors were designed by James H. Parcher of Leotta & Parcher, a leading industrial design firm in Philadelphia, Pa. This is actually the first slide projector ever designed specifically to use a plastic housing, and the first important use of rigid polyethylene in the photographic industry.

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FLUOREL Brand Elastomer is a highly fluorinated synthetic rubber that maintains excellent resistance to compression set, even at extreme temperatures. A half-inch disc of FLUOREL Elastomer, for example, deflected 25% for 70 hours at 350°F, will set only 30% of the original deflection when released.

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CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

Product Engineering — HORIZONS

August 24, 1959

is a will-o'-the-wisp

Creativity, out of Pandora's Box by Sputnik I, is the current favorite for winning the arms race—and the cold war, too—to say nothing of most of the local civilian claiming races. Nobody seems to know the blood lines of the filly, but she's getting endless headlines in the press. She bids fair, in fact, to replace that fast starter of a few years back, Brainstorming, by Committee out of Ideas.

You'll pardon this facetious reference to this present-day deux ex *machina* age, but what is a very serious needs is, as usual, being converted into a fad. There are as many definitions of the word "creativity" as there are people who know it, ranging from the Nobel Prize contribution at one extreme to the industrial equivalent of a Dior gown at the other. Everyone wants the really creative idea, but most of us are forced to settle for the improvement or facelift.

Perhaps it is this realization of a need that has developed our current national worship of the scientist and our almost-respect for the engineer. It has certainly brought into being some of our current automated research factories, with picture windows, views, tweeds, pipes and understanding—but very little creativity.

As Dr J. Bronowski of the British National Coal Board remarked recently, "Creation is a highly personal thing; it is something younger, poorly paid scientists and engineers do, and older, highly paid ones get together and talk about." It does not arise from plenty, but from lack. It is not born in a lying-in hospital for ideas, but spawned in adversity. Real top-level creativity seems to be an attribute of the young man, and this creates a paradox, for the older and proved man can get a hearing and support, but who will listen to the younger and untried one?

This is to be expected, for our society is a stable one. As Dr Bronowski says: "Society must resist change while it advocates it . . . Unconventionality only has meaning if there are conventions, and the creative spirit is perpetuated by eccentrics. Society must thus encourage these eccentrics while it disapproves of them, for they create problems which society must digest."

Thus we seem to be, individually and collectively, chasing a will-o'-the-wisp. Everything we can do to nurture this elusive thing tends to weaken it. Perhaps the initial comparison with a racing filly is the appropriate one, for we must in effect stake our national futures on unknown and untried horses, if the sages in this field are to be believed. To shed what light we can on the problem, we report in succeeding pages some of the results of "research on research" reported in a highly selective Harvard conference of research directors last month, with such side viewpoints as we have. The report will not show you how to guarantee creativity, but it will give you a net with which to chose this will-o'-the-wisp.

CREATIVITY...

Mark Twain's familiar remark about the weather might also apply to creativity–but out of all the talk some facts begin to emerge. Here are summarized those brought to light at a recent 3-day Harvard Conference.

E J TANGERMAN *Editor*

Fundamental discoveries are usually not accidents, much as they may appear to be. They result from attention to troublesome detail that the ordinary mind discards. The innovator does not throw away "spoiled" photo plates or bacterial cultures; he digs back to find out why they were spoiled. Many plates showed atomic action, many cultures showed penicillin, but for years researchers discarded them as faulty because they did not fit the pattern of what was already known. The researchers who stopped to find out why they were faulty made the discoveries. The basic characteristic is *driving curiosity*, something all children have, but adults grow out of. To increase creativity, we must start by preventing this growing up.

Creativity is a function of *people*, not of organization, or luck, or conditions, or desire, so any study of the subject must begin with some definition of the creative person and how to recognize him. This is not easy; there is good evidence that most of our colleges, as well as our industries, have rather carefully weeded such people out. One study by a college showed that the aptitude scores of those students who failed for academic reasons were higher than those of students who were graduated!

The Creative Man

Real creativity apparently occurs most often in the unconventional—even eccentric—individual. He has intense faith in himself and a willingness, or desire, to work alone. He is impatient with conventionality, whether it be rules and regulations, working conditions, or mentalities. Creation is a highly personal thing—whether it be artistic, scientific or emotional.

Says Dr H. B. G. Casimir, director of the Philips Research Laboratories in The Netherlands, "Most creative scientists have a number of idiosyncrasies—or perhaps even slightly neurotic tendencies—and they will feel happiest in surroundings where these are least evident. This is one of the advantages of a university as compared with an industrial organization."

Another point of importance: the creative person is usually young. Experts say the top age for basic innovations among theoretical physicists and mathematicians is 30 to 35, for experimental physicists 35 to 40, for biological and medical scientists 40 to 45. Thus the man with greatest potential usually is without reputation or experience, and the man with both reputation and experience is unlikely to produce anything basic. Creative scientists have much more in common with athletes than with artists and writers, whose creativity covers a much wider time span.

Tests during the past six years by UC-Berkeley's Institute of Personality Assessment and Research indicate that intelligence is much more important in creativity than education level. Tests covered creative people selected by their professional colleagues. Among those chosen, only the women mathematicians averaged high educational levels; the architects, writers and painters were most commonly without degrees—they'd left or been invited to leave college—yet their IQ's were all in the 150 to 160 range.

But not all intelligent people are creative —most lack the will or desire. And many lack the independent judgment. (This characteristic was tested in an interesting way. The subject was set for the test in a group of nine other people, presumably also testees but actually stooges. They were primed to give false answers to certain questions, so the testee had to pit his own judgment publicly against theirs!

Other fairly uniform characteristics are: an openness to experience (almost naïveté) even if the experience involves disorder and irrationality; esthetic sensitivity to beauty, particularly in form and dynamic balance, very deep concern with the philosophical issues and with the freedom and lawfulness in nature (a strong need for order, but *not* for conformity unless he's sure it meets nature's laws); and a willingness to stake his future on the meaning of his work. He has, as one expert put it, "good taste in selecting a project."

He is likely to be strongly anti-social, anti-authoritarian, may find refuge in excess in his personal habits. He regards his work as an expression of his own personality; it expresses and fulfils his personality and he assumes it shows his humanity. Thus he appreciates the opportunity to talk his problems over with qualified people to attain cross-fertilization of ideas, but he is likely to insist upon working alone. No organization can really deter him, and he is likely to feel that he can do everything on the job better than

the facts behind the fad

"Here is Edward Bear, coming downstairs now, bump, bump, bump, on the back of his head, behind Christopher Robin. It is, as far as he knows, the only way of coming downstairs, but sometimes he feels that there really is another way, if only he could stop bumping for a moment and think of it."

From the book "Winnie the Pooh," by A. A. Milne. Copyright 1926, E P Dutton & Co, Inc, renewal 1954, A. A. Milne. Reprinted by permission of E P Dutton & Co, Inc.

anyone else—even the shopwork, the ordering and the expediting. He is an inveterate gambler with his time and effort and the organization's money and facilities.

What is Creativity?

Creativity is basically the ability to produce new and interesting results from nature. But the word has been applied so broadly in recent years that it can represent any of four steps in science and engineering:

1. *Pure, basic research of the Nobel-prize level*—which perhaps 100 Americans are capable of doing. (After all, there have been only 60 basic papers presented on physics since Newton formulated his laws in 1687 up through 1933. With these 60, you could write any physics text.)

2. *Innovation and discovery*—say 1000 people.

3. *Invention*—say 10,000 can do.

4. *Problem solving*—say 100,000 people do this.

Actually, the common concept today is more likely to embrace Classes 2 and 3, with Class 1 hoped for and Class 4 questionable for inclusion at all.

You need not blush—nor will I—at our inability to define the word more exactly. Everybody has been trying to arrive at an acceptable definition, and none is known. But hundreds of experts are discussing it. This summer, for example, Prof John Arnold conducted his two-week seminar at Stanford, basically like his controversial 1953-55 ones at MIT, with industrial supervisors and teachers. Dr Alex Osborn and his Creative Education Foundation and the University of Buffalo co-sponsored a 3-day "creative problem-solving institute." And Harvard University invited 70 of the world's best-known creative minds from education, industry and government to a 3-day conference on "creativity in an organization setting." I audited the latter; it was stimulating, interesting and valuable, but it didn't catch the will-o'-the-wisp either—and it had the best chance. It did, however, picture the creative man, suggest how he can be selected and handled, and suggest as well how to use him effectively in an organization.

How to Find the Creative Man

There are as yet no effective tests for creativity—no way to guarantee you've found the man, nor any way to evaluate his work. Finding him after he's proved himself may be too late—unless you're seeking a manager or reputation. However, creative people seem to be able to spot creative ability, so a successful technique is the personal interview by—of all things—a committee of four or five people: the director of the lab, the candidate's potential superior, and a couple of creative people. Previous experience, degrees, and other usual criteria are of little help—you judge on faith, knowing the characteristics as described earlier. (See also "Are You Creative"—*PE*—Nov17'58,p 28).

The Setting

Authorities agree that the physical setting for creativity is less important than the mental or psychological one. Equipment should be adequate, but need not be elaborate; too much has historically been worse than too little. There should be few distractions; as Yeats replied once when asked if he had no telephone because he didn't like them: "No! I like them too well!" And there apparently should be some resistance; Dr Hatch of 3M said after retirement that the successful research project was invariably opposed by the management, and was carried out by a man who was willing to lay his job on the line in the face of this opposition.

There is evidence, also, that the creative person shouldn't have too much familiarity with the field, nor should people with whom he associates. Experts know all the reasons why the idea won't work, know all the rules—one or more of which must be disproved if any advance is made. Wisdom and experience, in the vicinity of creativity, turn out to be merely entrenched opinion and prejudice. Put these into a control or advisory committee and you have introduced rigor—the first word of *rigor mortis*.

Creativity doesn't countenance regulation either, so the really creative person won't observe usual employe rules or office hours. (Remember Steinmetz' ultimatum his first day at GE: "No smoking—no Steinmetz!") Nor will he countenance a static situation; if the organization is content with things as they are, the creative man goes out—or his creativity does. This is the problem of universities; the academic atmosphere dear to the creative mind is becoming obscured by poor management. Most universities manage research just as they always did—despite a 10-fold increase in funds. The creative person on the faculty has teaching, committees, fund-raising, and endless other interferences with his work. Also, he suffers from rigidity of equipment because many universities have invested in now-obsolete assisting units like computers and X-rays that they cannot or will not discard. Committees there are also on the increase, while in industry there is some evidence of decline. (The new president of one of America's largest corporations eliminated all committees—and nobody has missed them.)

How to Evaluate Creativity

Most measures of creativity thus far offered seem rather to be measures of productivity; they are largely quantitative. Technical papers (either in research-society journals or in all technical magazines) and patents are the criteria. One pair of researchers have even equated five papers as equal to one patent, simply because there are that many more papers than patents. The purist, however, argues that, regardless of jury, reviewer and editor standards, there are good papers and bad ones, significant and insignificant ones, basic and trivial patents. One study, for example, shows that in the tree-shaped development of one basic idea, there were six additional Nobel-prize winners—so even a Nobel prize is no guarantee of a basic contribution.

One company shows productivity of 0.28 papers and patents per professional in a 500- to 600-man lab, a gradual rise from 0.20 to 0.27 in another as the staff increased from 40 to 150. (This company discovered, incidentally, that up to 30 or 40 men in a lab require almost no management, between 40 and 100 a loose

departmentalized structure is necessary, and above 100 a formal organization with definite channels of communication and an increase in management levels is required. Morale problems are bad during changeover.)

An extensive study of productivity, made by Arthur D. Little, Inc., is about to be published by the Office of Naval Research. This includes some rather surprising results, among them the indication that publication rate among physical scientists is high until the man receives his doctorate, then drops off rapidly to about 20% of the earlier value. Fellows of the physical society publish ten times as much as non-fellows; the ratio of academician publications to those of non-academicians is astronomically high. Also, only 20 to 30% of the doctors in physics and chemistry stay in research, but half of these write 70 to 80% of the papers. At right is a table from the same study, showing some relationships in money, men and papers.

RATIOS OF MONEY, MEN AND PAPERS IN RESEARCH

Type of Organization	Basic-research Expenditures, %	Publication Rate, % of Total	No. of Researchers % of Total
Government	11	9	7
Industry	39	19	27
Education & non-profit	50	72	66

Note: No correlation was found with patents, probably because of the vagaries of patent law. George Washington University has just reported that 55 to 65% of patents granted are, or have been, commercially used, as against the usually quoted figure of 5%.

Not all societies are interested in creativity. Insects, for example, stopped evolving a long time ago (ants nearly five million years ago). They are satisfied with what they are, see no reason for change. They discourage originality or creativity by eliminating innovators . . . Among men, only two societies have been truly creative, Athens from the sixth to fourth century BC, and after the Renaissance in Europe. Sparta was too moral, Egypt too religious, China too contemplative . . . The society must be stable, but interested in change (hence not static), must be more concerned with what you produce than the way you live, must be impressed by action and future, not contemplation and life after death.—Dr J Bronowski, England

Costs and Their Control

My own survey of R&D six months ago (PE-May 11 '59, p 47) indicated that companies are trying to divorce this budget from operating budgets—to make it a capital investment just like plant, independent of sales. Actually, two factors work together to establish budget anyway: (1) number of professional people, (2) capital equipment. For each professional worker, the annual budget will be something between $20,000 and $25,000 (or more, see Oct 6, '58, p 23). Thus, costs can be controlled by controlling number of professional people. Capital equipment (without buildings) will be 10-12% of the cost per year of the staff. This figure, incidentally, shows why it is advisable to discard slow or obsolete research equipment promptly—the potential loss in working time is far greater than the investment represented by the equipment. In one case, a British lab completed a $500,000 mechanical computer, just as a far-cheaper and far-faster electronic one was announced. The discreet move was to discard the new unit after it had handled only a few problems.

The creative man wants freedom of choice in projects; the laboratory must show results in certain directions. How can these two be reconciled? If the sponsor is smart and sensible, he can control results in two ways: (1) by initial selection of his men, so their interests and his coincide at least roughly; (2) by explaining what his objectives and interests are in clear terms. If he can outline his general area of interest, the researcher then has full freedom of decision within the area as to problem, method and development. His close association with the field will suggest which doors are open, which ajar, which closed, and he can best choose between them. He must be reassured, however, of the sponsor's understanding that blind alleys will occur, that timetables are for routine workers, that a given project may pall.

Yet the time advantage in innovation is vital; a year or two years of time advantage is all a present-day sponsor can expect out of his investment. This means that development phases must be rapid once an idea is discovered—it was the concensus at Harvard that a major present Soviet advantage is the ability to capitalize faster on new science. Our scientific knowledge is as good as theirs, but they make hardware while we fight encumbrances such as company and governmental secrecy.

The need for speed in developing ideas is in direct conflict with the creative mind's desire to present its findings to its peers in a technical-society paper. This may delay disclosure for a year or more, may jeopardize or lose the sponsor's time advantage. Usual procedure now is to patent only products; processes are kept secret; this gives no competitor a blueprint of procedure. Thus GE announced artificial diamonds but did not divulge the catalyst in the process.

Basic research always appears to be thoroughly disorganized; but there is plenty of evidence that good organization results in trifling research. The slipshod university atmosphere has up to now resulted in far more basic discoveries than has the more shipshape company atmosphere. This should be a warning that the lay idea that all research should be centrally planned and organized for efficiency will result in chaos—lots of projects but no results.

Dr. W. D. Lewis, director of systems research at Bell Telephone Labs, gives these rules for directing group research:

1. "Direct" means "guide," not "specify"—The important output of research is new information, new understanding, and new techniques. Because the commodity to be produced is not known in advance, it is inherently impossible for a research director to specify close deadlines and narrowly defined goals. It could be said that goals and time limits are for research what adrenalin is for the heart. The right amount can stimulate, but too much can cause failure. Goals should be presented as opportunities or

Growth (in science and technology) has been so rapid that 90% of all of the scientists who ever lived must be alive today. Science and technological change had almost no impact on the outcome of World War I, while it was a major factor in War II. The great economist Lord Keynes didn't recognize technological innovation as a factor in the economy twenty years ago, yet today it assumes major proportions.—Dr Guy Suits, GE Research

challenges, but only rarely as obligations.

2. Researchers are human too—They need to be appreciated, encouraged, and fairly rewarded just like anyone else. The rewarding must be done with particular care in group research where there is some danger that individual credits will be submerged.

3. Provide help—This means physical help, laboratory apparatus, and adequate technical assistance. Genius may be 1% inspiration and 99% perspiration, but these need not be provided homogeneously by all people in a research organization. Those who are more capable of inspiration should be able to delegate a judicious share of the perspiration. Furthermore, they should be made as free as possible from the ever-encroaching tangles of red tape and onslaughts of Parkinson's Law.

4. Stimulating atmosphere—A more crucial kind of help is that provided by an atmosphere loaded with ideas. Ideas come from people, so this means bringing clever people with different backgrounds into contact with the group and encouraging the interchange of ideas. Shockly has conjectured that inventive creativity is strongly enhanced by the ability of the brain to be aware of more than an average number of ideas simultaneously. The arrangement of these ideas in a new combination must occur first in the mind of a single individual, but the availability of these ideas around him greatly increases the likelihood that this will occur.

The number of simultaneous but independent great inventions and discoveries force us to believe that the climate of ideas may be as essential to technical creativity as the presence of minds capable of combining them. No savage, however brilliant, could have invented radio.

5. The creative group must not demand conformity—A characteristic of most human groups—military, religious, industrial, and social—is that they impose conformity in one way or another on their members. This can be dangerous in a creative group. Creativeness is not just the ability to lay bricks. The component ideas and lines of thought which go into a discovery or invention must be different from each other, and the result must be different from anything that existed before. Crossing of strains is known to be as fertile in science and technology as in botany. A well-known example is the impact of physics on electronics, especially on radar in World War II and in the creation of the transistor. It took mathematical logic as well as engineering to bring forth the electronic computer.

When put in terms of people, this means that the most creative group is likely to be the one which least demands conformity, except possibly to one thing—belief in the importance of creativity. Different members of the group must have different characteristics, different skills, and make different contributions. Some will be highly creative, others skilled technicians, still others project engineers. These different sorts of people will probably have different work habits, and these differences should be understand and approved by all members of the group.

A solo chess player can always beat a committee, because the committee inevitably agrees upon the best next move, while the individual plays to a long-term, over-all strategy. So it is with creativity. One man makes no compromises, deals in fundamentals . . . Man is the only social animal who works alone.—Dr J Bronowski

Individual vs Team

Evidence and opinion point to solo operation by researchers—most patents are granted to individuals and most papers have one principal author. Basic research flourishes in solitude. But there is so much work to be done, and the need for speed is so obvious, that multiple work should in theory speed up the process.

A study by GE of 239 articles in the *Physical Review*, Vol 113, Nos 1-5, showed 89 papers with one author, 99 with two, 35 with three, 13 with four, two with five, and one with six. Average is two authors per paper, or 4¼ if collaborators are counted.

At Bell Labs, there are 280 professional people in Research Division A, 80% of whom work as individuals, and 170 in Div B, 80% of whom work as groups. Based on discoveries and technical papers, Div A is more creative; Div B when measured by inventions and patents. On one accepted equating basis (5 papers per patent), Div B is 50% ahead of A; on another (2 papers per patent), they are equal. If patents and papers are added, the groups are equally creative on a contribution-per-man basis.

Tests by psychologists show that groups get better solutions to problems than individuals, but not more per member, and dividing the problem among individuals and adding all the answers gives an even-higher total. Groups tend to correct each other's mistakes, so the group *judgment* reduces quantity and improves quality—the individual produces more good designs, also more bad designs. The rule: The individual is better at action, the group at judgment.

Yet the new PhD needs guidance—usually welcomes assignment of a problem. Later he develops individuality, but it often is not there initially. He is too diffident, too herd-bound, too inexperienced to want to strike out on his own at first. Later on, when he does, any effort to stop him will only make trouble.

What to Do with the Older Man

Assuming the evidence on youth of creative people is correct, and your goal is creativity of the basic type, the older man will be non-productive. But he certainly should be neither discarded nor misused. He should not become a paper pusher nor janitor at high salary—he'll only become dissatisfied and jealous. The latent desire for decision-making is there, stimulated by both social and technical pressures. He can appreciate and understand the creative work of younger men, can advise and help. And running the lab itself is a truly creative job. He can see that jobs are rotated so boredom doesn't kill initiative, he can teach, write papers and books, spark creativity types 2, 3 and 4. He can do the committee jobs, supervise the collecting of information, can make administrative decisions that will be acceptable to younger creative men. From the company standpoint, here is a man with proved creative ability plus experience which should not be wasted. The alternative is to use the younger man, still in his creative phase, for less-creative work—a procedure which may bring us to scientific bankruptcy in ten years.

Incidentally, R & D lab heads should be changed in six to ten years. Otherwise, the creativity and results both drop off. ■

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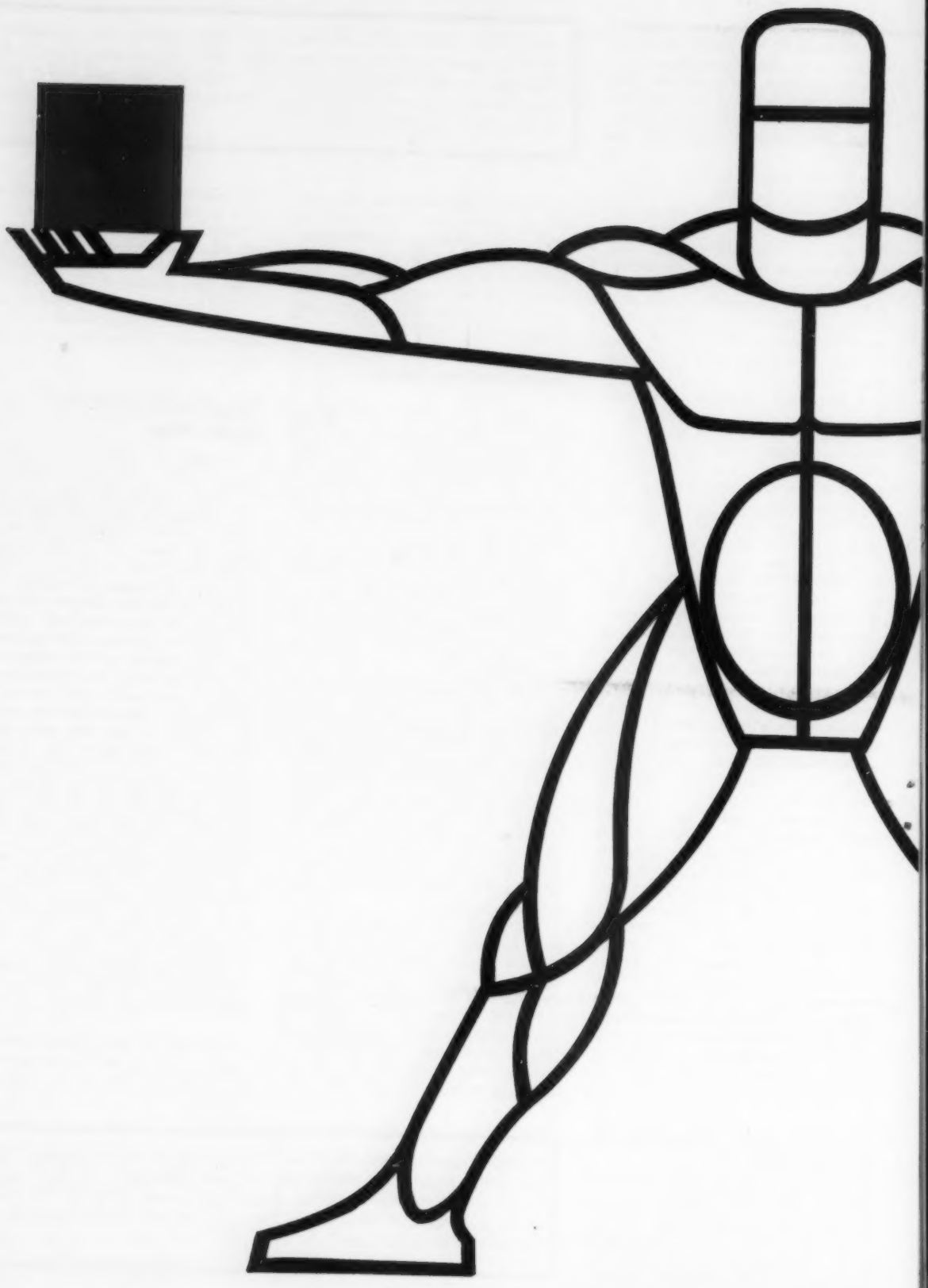
Creativity jeers at time clocks, and this complicates administration. Said the former head of the Philips Research Labs (Holland): *"I don't resent a man who is two hours late (his technicians assume he was at the patent office, head office or elsewhere on business), but I do resent a man who is always just ten minutes late."*



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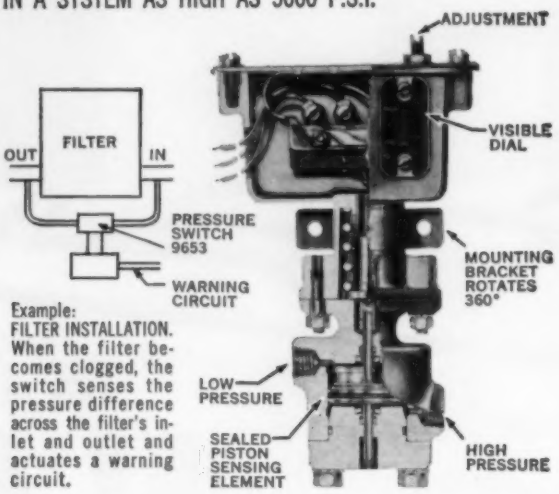

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Cooperative Research Advances Engineering Knowledge

Competing companies work in harmony to advance state of the art. This method permits R & D and engineering to concentrate on other projects, giving a two-prong attack on future markets.

NEW YORK — Competing business firms are showing signs of cooperating in one phase of their activity—technical research. In some respects, R & D and engineering is a frustrating pastime. Every piece of research that is reported in a technical journal or ends up in next year's model more likely than not points up the acute need for several other projects. But if a business backed all potentially useful R & D, the corporation would go broke.

Hence many companies are supporting cooperative work of various kinds. Many trade associations are dropping their role of technical forum for the more active role of originator of research. On completion of such projects results become common property. Sometimes, too, individual companies join together outside the cloak of a formal organization to get promising long range work done at a research institute or university. One research institute says that nearly 10% of its work is in this area. Individual companies also join to finance research equipment that calls for heavy capital investment.

Research by a group of companies for their mutual benefit is by no means new among professional engineering societies. The American Society of Mechanical Engineers saw the need for a research program and organized one as far back as 1909. The American Society of Heating, Ventilating, and Air Conditioning opened a lab for technical research for its members in 1919.

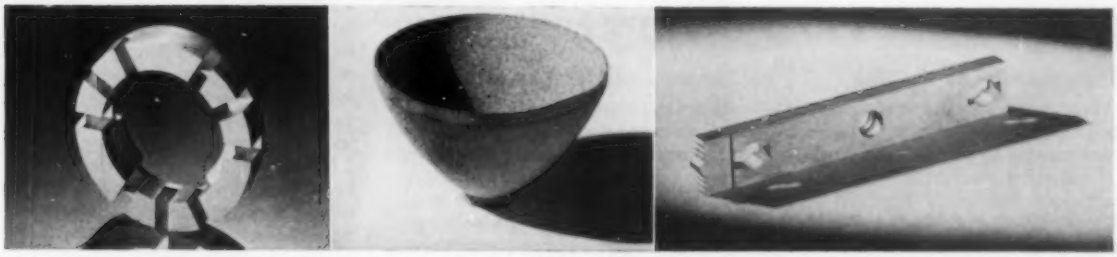
But the gap between what can be done and the wherewithal for doing it is creating an atmosphere in which corporations are willing to chip into projects that advance the common welfare. One reason is that technology is moving so enormously fast that companies are finding difficulty keeping up with the state of their own art. A wisely tailored research program within the corporation should advance the art, not duplicate work already done and reported in technical journals here and elsewhere in the world. Hence, a good many trade association programs are in the vital though seemingly unspectacular field of literature searches to find out where the art stands.

To cite one example that illustrates the scope of modern-day literature searches, the American Society of Tool Engineers offers, as one of the major accomplishments of its five year old research program, a 275-page volume that evaluates present understanding of metalcutting. This work summarizes the literature on the subject and appraises current metalworking theories.

The enormity of research today is blurring lines between competitors. Occasionally companies are finding that they have to cooperate with competitors if they are going to fight competition that rears from a supposedly remote area. A case in point is a comprehensive and basic study of wood now under way at the Battelle Memorial Institute for four major firms in the wood industry.

Under the new research program, Battelle is searching many areas for a practical low cost way to improve the properties of wood. Possibilities include chemical cross-linking to tie wood molecules together or material

Top Trio in Metal Powder Competition

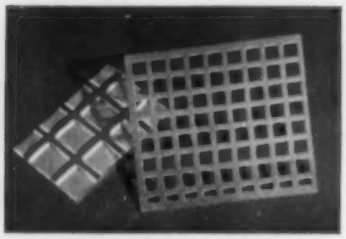


The shaped charge liner (center) designed by R. F. Hatfield, Jet Research Center, Arlington, Tex, won first prize of $200 during recent Metal Powder Press awards competition. Formerly made of drawn copper, it utilizes special properties of brass powder metallurgy in carrying out function of holding charge in place inside an industrial missile. Controlled particle size and density of part allows complete frangibility for penetration of an oil well liner without the clogging effect of solid metal particles. Second prize of $100 (left) won by Meredith E. Smith of Minneapolis-Honeywell Regulator Co. is a part made of nickel silver powder and molded in a plastic form. By so doing and machining away the base webbing, company saved $1.97 per part over conventional method of assembling individual terminals to a pre-molded block. Controlled electrical conductivity of sintered nickel silver powder, a non-rusting finish without plating, improvement of the design and a greatly simplified assembly were reasons given for conversion to powdered metallurgy. A third-prize winner of $50 (right) submitted by Phelps K. Tracy and Lewis N. Hatch of Foxboro Co, Mass., is a part formerly machined from a rectangular brass rod. By utilizing powdered metallurgy process, some 16 operations were eliminated, closer tolerances were achieved, a better non-rusting apparance without plating was obtained and assembly procedures simplified—all at 1/10th the cost of the conventional method (old price $1.10 each).

Kodak reports on:

a new method of metalworking . . . a method for forecasting titanic stress in fine detail . . . lower cost for a machinable photographic plate . . . clear, competitive vision in the 2-8μ region of the infrared

Photo-milling



New methods of metalworking do not come along often enough to be ignored. Here are two examples of what we call "photo-milling." The one on the right could, of course, have been done on a punch press if die cost had been justifiable. No die was used, nor were the openings cut individually. The one on the left looks like a milling machine job, for sure. It isn't.

This sort of thing is now best done photographically with a new light-sensitive preparation called *Kodak Metal-Etch Resist*. You spray it on, or dip, and dry. Then you expose to bright light under a film on which you have photographed the pattern. After a simple development, a flush that washes away the resist where the pattern kept the light off, and a bit of baking to remove the developer solvent, the metal is ready for whatever chemical or electrolytic etching works best. The resist protects from etching action vigorous enough to remove a quarter-inch of aluminum and considerable depths of stainless steel, tool steel, magnesium, titanium, and possibly some metals we know nothing about. To get the benefit of our thinking on the subject, write Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y.

Photoelasticity by the slice

Westinghouse, long known as a hotbed of photoelastic activity, has been nice enough to cast upon the waters of industrial co-prosperity a piece of technique that could help sell more *Kodak Contour Projectors*. No time must be lost in spreading the word.

Westinghouse took one of these projectors of ours and turned it into a magnifying polariscope. This they did in the interest of reaching reasonable decisions on the mechanical design details to enable a nuclear reactor pressure vessel to withstand the titanic stresses that it must bear.

Scale models were built out of a certain transparent epoxy resin which not only exhibits the well known differential retardation between light polarized parallel and perpendicular to the stresses, but can retain the effect "frozen in" after the pressure is released and the model is literally sliced up in various planes of interest to the stress analysts. The *Kodak Contour Projector* is what brings the analyst in close, past the gross structure of the pattern, to the all-important fine details where structural failure starts.

Don't bother Westinghouse for a description of the optical, mechanical, and electrical additions they've made to the projector. It's enough that they are publishing a full description of the analytical method (Proceedings of the Society for Experimental Stress Analysis, *17*, No. 1). *They're not interested in selling projectors. Eastman Kodak Company, Apparatus and Optical Division, Rochester 4, N. Y., is.*

Plates drop; don't shatter

The price of *Kodak Photoplast Plates* has been cut. If you want to photograph a pattern on a shatter-resistant, rigid support that can be conventionally machined and maybe used as a computing element or as a master for printed circuits, you have that much less reason to shy away from these 8″ x 10″ methacrylate-base plates.

Thickness	New Price
.060″	$55.20 per package of 12
.130″	31.05 per package of 6
.250″	23.00 per package of 4

To locate a dealer or to ask about other sizes and the possibility of light-diffusing methacrylate for the base, write Eastman Kodak Company, Special Sensitized Products Division, Rochester 4, N. Y.

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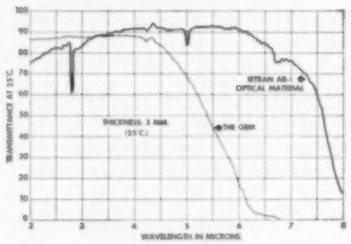
Around this whole package of technology we put a convenient string and tag it with a new trademark, "Irtran." Immediately—so robust is the American economy—we find ourselves in competition with some excellent fellows who also possess the above-named qualities and who make a most excellent infrared-transmitting optical material—a gem, synthetic but true, with a gem's name. To spell that name out would be as unmannerly as it is unnecessary for those caught up with infrared-actuated swords and plowshares.

Rather, we want such cognoscenti to spell out *Kodak Irtran Optics, Type AB-1*.

They cost a lot less than the gem makers have to ask.

They see clearly through the 3-5.5μ windows of the atmosphere.



They stay clear to at least 800°C instead of permitting Herr Kirchhoff's law to blind them by their own emissivity.

They have a refractive index of only 1.301 at 6.7μ, paying scant tribute to M. Fresnel's celebrated equation about reflection losses.

They survive all the high temperature, thermal shock, weathering, humidity, and abrasion that the current tests for swords require.

Type AB-1 is only the beginning of the *Irtran* business, we suspect. Quartz was fine when lead sulfide was the practical detector; PbS quits at 4μ. Now the longer wavelength sensitivity of cooled lead selenide, lead telluride, and indium antimonide has outrun the transparency of good old quartz. Soon the boys will be banging on the 8 to 13μ window of the atmosphere. For lenses with optical power they'll want infrared-transmitting material of higher refractive index. *Type AB-1* may be only the beginning.

With what excitement the specifications for us to quote on will be drawn up and shot off to Eastman Kodak Company, Special Products Division, Rochester 4, N. Y.!

Prices are list and subject to change without notice

Kodak
TRADE MARK

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

to fill microvoids in wood. Such projects are generally beyond the ability of a single firm to do on its own.

DIGGING FOR PAYDIRT

An area of research often offers promise, but considerable engineering data lie between promise and payoff. Research directors cannot get money or personnel for such projects. One such area is thermoelectric cooling. Engineers have long recognized that cooling without moving parts is possible through application of the Peltier effect, but at present lack of information about thermoelectric properties of materials is retarding engineering development of such equipment. To speed development, 16 companies are having Battelle make a 2-year study of a wide range of compounds and alloys of compounds that are promising but heretofore uninvestigated.

Another factor that is encouraging a type of cooperation is the high capital investment required for some modern research equipment. One such installation is Industrial Reactor Labs—a private firm financed by 11 companies whose research can be furthered by a nuclear reactor. They have constructed a reactor of swimming pool design that is now in final test stages. It produces 5 megawatts power—the highest for this type reactor according to sources connected with the project. The 11 cooperating companies—American Machine and Foundry, American Tobacco, Atlas Powder, Continental Can, Corning Glass, National Distillers and Chemical, National Lead, RCA, Socony Mobil Oil and US Rubber—will use the reactor jointly and analyze results at private individual labs located at the facility.

Armour research also has a nuclear reactor for research. Theirs is financed by 24 companies, each of which contributed $20,000 for a three year stake in basic research results that are forthcoming.

Another case of joint equipment is a wind tunnel that California Institute of Technology operates for Douglas, Convair, Lockheed, North American Aviation and McDonnell Aircraft. Known as the Southern California Cooperative Wind Tunnel, this facility was opened in 1945 and thoroughly modernized in 1956. Replacement cost is set at $14 million.

TRADE AND PROFESSIONAL ASSOCIATIONS

Trade and professional societies with formal research have programs that vary considerably in procedure and objective—but all are of general interest to members. The ASME sticks closely to what it describes as background research. By ASME definition, pure research provides theory; background research the vast amounts of engineering data that are required to produce hardware. The ASME presently has 20 committees with more than 700 committee members who are responsible for selecting projects that will benefit members who are designing in a fairly broad range of industries. These projects should fill in present gaps in engineering information and practice. They always lead to information; never to patentable items. Support is obtained from industrial firms who will benefit from the new information and is forthcoming in the form of money, services of engineering staff employees, and research equipment.

Curiously, about ½ of ASME committee members are not members of the ASME. Many current projects require technical knowledge from specialists outside the field of mechanical engineering. A study of the effects of temperature on the proper-

Some Cooperative Projects and the Sponsoring Agency

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Fluid Meter Committee—Ultimate goal is a textbook covering theory and practical means of measuring pressure that occur when fluids and gases flow under various temperature and pressure conditions.

Properties of Steam—Keenan & Keyes tables will be extended to higher pressures and temperatures required for present-day design. At present, designers extrapolate on basis of old tables without experimental data describing high temperature behavior.

AMERICAN INSTITUTE OF MINING METALLURGICAL AND PETROLEUM ENGINEERS

Corrosion Research Council—Fundamental, long-range investigation of corrosion at metal surfaces and mechanism of stress corrosion cracking. Included are studies of mechanism of stress corrosion cracking of AZ-31-B, magnesium alloy, decarburized steel, and ship plate steel, and the role of hydrogen in mechanism of stress corrosion cracking of low-alloy steel.

AMERICAN GEAR MANUFACTURERS ASSOCIATION

Gear Standards—Comprehensive formula for rating gear tooth strength and durability. A new family of standards is due in Oct 1959.

AMERICAN SOCIETY OF TOOL ENGINEERS

Cooling Characteristics of Cutting Fluids, M.C. Shaw, N.H. Cook, P.A. Smith of MIT have reported surprising theory that cutting fluid can be too good as a coolant.

An Investigation of Temperature Distribution in a Workpiece during metal cutting using both thermocouple and analog computer techniques. Results of the two methods are compared and discussed. Work is being done at Columbia Univ.

LEAD INDUSTRIES ASSOCIATION

Fiber-reinforced lead—To develop lead fiber composites that possess strength and creep resistance superior to homgeneous lead. Present work on composites lead and tin bronze felts is underway at Armour Research.

High-emission lead compounds—Study of Thermal and spectral emissivity of lead compounds for heat transfer and electronic devices by Prof. Cadoff at NYU.

AMERICAN ZINC INSTITUTE

Corrosion in galvanized hot water tanks—Goal to develop alloys with corrosion resistance to hot water. Photoconductive and X-ray analyses will aim to verify theories of corrosion derived from solid state theory.

ties of metals for example, is drawing heavily on the knowledge of physicists serving on the committee. This committee—the ASTM-ASME Joint Committee on the Effects of High Temperature on Metals—has completed study of properties of stainless steel, steel alloys, cast iron, copper, copper base alloys, weld deposited metals and weldments. It is now studying the feasibility of punched cards for recording and filing all test data.

PRACTICAL APPLICATIONS WANTED

The American Zinc Institute and Lead Industries Association tie their 3 million dollars of research more closely to commercial payoff. This large scale program is only about a year old. In choosing suitable projects, a Technical Steering Committee, composed of a top technical person from each of the 60 member organizations, proposes studies which are feasible and essential to advance the technology. These technical suggestions are reviewed by a market development committee in terms of what the project will do to further saleability of lead and zinc.

In contrast to many other associations, the LIA and AZI believe that they may produce some patentable research.

The American Society of Tool Engineers is still relatively new to research and excited by the prospects. The ASTE strives for a delicate balance that avoids narrowly applied projects but still insists on useful projects. Ideas originate with universities, research institutes, industrial organizations and individuals. These ideas are screened by experts in the tool field and if found promising are turned over to a steering committee which determines what should be done and how. Actual research is done in research institutes, universities etc.

To date, the ASTE has sponsored six research projects that have resulted in 21 publications.

A SOCIETY LAB

The American Society of Heating, Refrigeration and Air-Conditioning Engineers says that it is the only professional society to operate its own research lab. The lab budget, now running $300,000 a year, is obtained from membership dues (40% of all member dues go for research), contributions from individuals, associations, business firms, government agencies and from the International Heating, Ventilating and Air Condtioning Exposition. Projects—all of which are reported in the ASHRAE Journal, ASHRAE Data Books, or otherwise published—include studies of applications of solar energy to heating and cooling, collection of basic data on heat pumps, measurement of sound and vibration in equipment.

The Investment Castings Institute has a cooperative research program which differs from those above in that all work is done in labs of association members. Member companies suggest projects, which are screened by a research committee. A list is circulated among member companies (*PE*—Mar 23, p 21). Each member is expected to take on one or more of these projects, or to substitute one of its own choosing. Upon completion results are circulated to all members. None of the projects is of a kind that will lead to patents. The program, which began last November, has produced three finished assignments so far. The completed works are a study of the effect of die temperature, wax temperature and pressure on cavitation in wax patterns (Precision Metalsmiths, Inc), the effect of aging time and temperature on the mechanical properties of 17-4PH (Cannon-Muskegon Corp), and a study of the properties of AISI-410 (Precision Metalsmiths, Inc).

This listing of cooperative ventures by trade and professional associations is representative—not all-inclusive. But it demonstrates that many new research programs are under way. And old programs are becoming larger. In the view of those who are appealing for research funds, such projects are not counterbalanced by a drop in engineering activity within supporting companies. These projects ordinarily provide more complete engineering data or accomplish work that companies would not do on their own, but adding to their knowledge. ■

Power Unit of Tomorrow Is Nuclear

Designed to drive a tractor and operate its air conditioning unit and heating plant with a nuclear capsule a year for fuel is conceived by the design staff of Briggs & Stratton Corp, Milwaukee. The blue-sky unit for a comfort indulging lawn mower and garden tractor combination will supply 500 BTU's an hour to warm the enclosed cab and power to run a 300 watt electrical generating unit. The generator drives lights, radio-telephone, cigarette lighter and radar. (Radar is necessary to precision trim trees and bushes.) This is indeed a unit to indulge the talent of a mechanical idiot—if such is the nature of the gardener. It has no pistons, connecting rods, crankshafts, valves, bearings, ignition system, no parts to wear, no adjustments to make, no lubrication ritual to remember. Though scientific formulas to measure nuclear horsepower are presently lacking, the unit is assumed to develop 10 hp at 12,000 rpm.

Congress Slow to Limit State Taxing of Out-of-state Companies

WASHINGTON—Congress is moving slowly in an effort to write new legislation to limit the power of states to tax income earned inside their borders by out-of-state companies. Since last March, a host of proposals has been submitted on the subject. Generally, the aim is to bar a state from taxing income of a company doing only interstate business within its borders, unless the company has an office, warehouse or other places of business in the taxing state.

For example, a hypothetical company whose manufacturing and sales operations might be located in the state of Illinois could not be taxed (as they are now) for sales made in another state, say Arkansas, where the company does not maintain any facilities.

So far, a bill along these lines has been approved by the Senate Finance Committee. But the House Judiciary Committee, to which the problem has been assigned in the House, won't begin to hold hearings until sometime after Congress adjourns. This means that new legislation in the complicated field of state taxing powers will be up for debate and argument again next year.

The push to make some sense out of the long-developing confusion in the law on state taxing authority was sparked by several recent Supreme Court rulings. Last February, the Court upheld Georgia and Minnesota taxes on the income earned inside their states by two interstate companies. In both cases, the only activity consisted of maintaining sales offices inside the taxing states.

The legislation, approved by the Senate Finance Committee, would ban state income taxes on interstate companies if their operations inside the taxing states were confined to sales activity and offices.

Thus, the Senate version goes a little further than most other proposals, which would ban such taxation unless the interstate company maintains an office, warehouse or other business inside the taxing state.

These proposals would apply only to situations like that involved in two Louisiana cases, which the Supreme Court—after its rulings on the Georgia and Minnesota laws—refuses to consider. The only activities conducted inside Louisiana by two companies challenging the tax was soliciting orders. Not even office space was maintained by either company. The effect of the Court's refusal to hear the company appeals in the Louisiana cases was to uphold the state tax.

The groups who have supported new legislation—such as the US Chamber of Commerce, the National Assoc of Manufacturers, and various small business groups—realize the problems involved. For one thing, no one suggests that it is a complete answer just to limit state taxation of interstate companies to those states in which companies maintain some sort of permanent establishment.

An interstate compact, for example, has been suggested as one way of solving the problem. Other legal authorities believe a constitutional amendment may be necessary to actually overturn the Supreme Court rulings. One thing is certain: whatever new legislation may be adopted next session by Congress, it will be only the first step in untangling the whole problem with a lot more study probably to follow. ■

Ti For High Speed, Low Inertia Gears

LYNWOOD, CALIF.—Titanium gears for heavy loads and rapid metal-to-metal contact (up to 825 ft/min) are within sight, according to the Western Gear Corp here. The company has developed a heat-treated electroless nickel plate that prevents galling which normally afflicts titanium gears.

The company also reported that a cyanide bath is suitable for lightly loaded gears in a nickel-corrosive atmosphere or heavily loaded gears that make slow metal-to-metal contact (up to 200 ft/min).

These conclusions are the upshot of a five year exhaustive investigation of titanium gears for the Air Materiel Command.

Lab tests with the new surface coating (which bears the trade name Western Gear Phosphorous-Nickel Coating) show the following gear performance characteristics, the company says:

- Wear is superior to many widely used bearing steels.
- Gears show high resistance to scoring at temperatures up to 800 F—or about 200 F above effectiveness of best known lubricants.
- Gears withstand loads up to 82% of case hardened steel for 10 million cycles in the Hertz stress range of 183,000 psi. Gear weight for titanium is about half that of steel.

For longest gear life under high compressive stress the Western Gear report recommends Ti-155A produced by Titanium Metals Corp of America. This alloy can be heated-treated along with the coating to produce Rockwell hardness greater than 60 for the case and 30-40 for the core.

For cyanide baths, Western recommends TMCA's Ti-140A.

Though the plate is very promising, the company cautions that actual commercial application awaits some additional research. One problem is plate flaking that apparently results from inconsistencies in processing. Solutions may be found in the plating bath where by-products cause some damaging unbalance that is not yet fully understood.

Studies of potential application will have to be made to find out whether the lower corrosion resistance of phosphorous-nickel compared with titanium alloy will impose limitations. And study of potential applications is also needed to learn whether ferro-magnetic properties of nickel coat will affect sensitive instruments. ■

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Elements for High Speed Computation

NEWPORT BEACH, CALIF.—Ultra-high-speed computer elements are expected to result in faster, cheaper and much smaller computing equipment. Included are: missile and satellite installations, language translation, library searching, decoding and scientific computation, says Aeronutronic, a div of Ford Motor Co. BIAX elements are small rectangular bars (50 by 50 by 85 mils) of ferrite magnetic material.

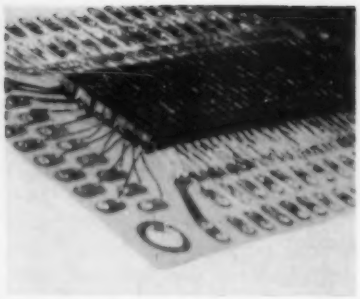
Basic concept used is flux interference between orthogonal magnetic fields. Interference takes place in the magnetic material between two 20 mil orthogonal holes. Because of the orthogonality, no normal magnetic coupling occurs between conductors associated with the two holes in the materials.

By controlling the spacing between the holes, the flux interference techniques can be made either destructive or nondestructive. Memory applications use the nondestructive element whereas logical circuitry makes use of the destructive element. In the memory unit, one of the orthogonal holes acts as the storage axis while the other hole acts as the nondestructive interrogate axis. The logical element uses the same technique except the holes are spaced extremely close together.

Significant points claimed for the computer elements are:

- Memory units can be interrogated without loss of information. Magnetic-core types require writing the instructions back into the unit each time an interrogation is made. BIAX elements have been interrogated over 100-billion times with no loss in output signal.
- Units operate over a wide temperature range—from 260 F to well below the freezing point of water.
- Elements may be densely packed giving very small volume. 200 flip-flops and 3000 gates—the equivalent of 15,000 to 20,000 semiconductors—can be packaged in $\frac{1}{10}$ of a cu ft.
- Solder connections in a typical computer will be reduced by a factor of 10 to 100, because many elements may be linked by a single wire. Number of connectors will also be reduced by a factor of 10 or more.

BIAX element is regarded as an intermediate—although not temporary—device in progress towards higher operating speeds. Aeronutronics is also



300 BIAX elements . . . are mounted on the printed circuit card for an electronic computer memory unit. Multiples of such printed circuit cards are mounted adjacent to one another in a computer to give large memory capability.

working in the area of "thin-film" devices, for use in even higher speed computers. However, Bill Frady, lab director of the digital computer group, says that thin-film devices are still in the future while the present element is available immediately, and has enough versatility to insure permanence in the field. ■

Educators Confer On Engineering Curriculum

CLEVELAND — Educators from more than 100 North American colleges and universities will gather on the Case Institute of Technology campus here next week to discuss new approaches to engineering education.

Special emphasis will be placed on new materials and what electrical engineering students should learn about them. Also, certain advance concepts such as electrified gas or plasma for transportation and the interaction of light with materials will be discussed in terms of their proper place in a modern curriculum.

The workshop is a sequel to one held at MIT in the fall of 1957. The National Science Foundation will provide necessary financial support for travel and living expenses of the participants. ■

US Seeks Better Count of Technical Resources

WASHINGTON—Government census takers are turning their computing eyes on engineers. The decennial census scheduled for next year is aiming for more detail on scientists, engineers and teachers than have preceeding counts. With the final tally, the

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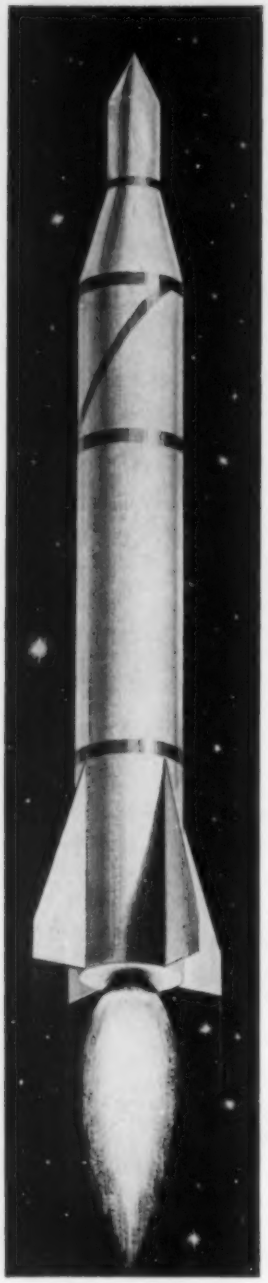

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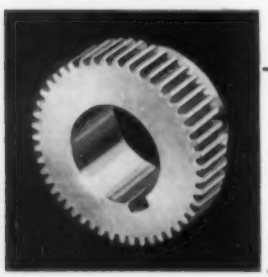

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government expects to have a statistical picture of the age, education, sex, income, and most recent work experience of the nation's technical personnel.

Engineers and technical personnel will be divided into several classifications. These include: draftsmen; aeronautical, chemical, industrial, mechanical, metallurgical, mining and sales engineers; electrical and electronic technicians; and technicians with other engineering and physical sciences.

The National Science Foundation and the Bureau of Labor Statistics are also collaborating on a special study of employment and utilization of scientists and engineers. This study is now in progress.

Elsewhere, pressure to enlarge and modernize the National Roster of Scientific and Technical Personnel is mounting. By law the National Science Foundation is obligated to keep an inventory of the nation's scientists for use in the event of national mobilization. This roster covers about 175,000 scientists but only 15-25,000 engineers. The register includes such data as addresses, occupation, education, etc. Presently, updating occurs every 2 or 3 years and this lag in the view of many concerned with mobilization problems somewhat limits usefulness of the listing.

This summer, a house committee held hearings on the advisability of setting up a committee to study national need for a permanent, comprehensive, and current record of scientific and technical personnel. Such a committee would consider the costs and methods of establishing a complete roster. No legislation has been proposed yet. ■

Home-study Course Offered by Military

WASHINGTON—The Industrial College of the Armed Forces at Fort Lesley J. McNair is appealing to qualified civilians in business, industry and the professions to enroll in its graduate level correspondence course. Based on the regular 10-month resident course for senior military officers, the correspondence version is presented in 22 bound volumes and takes one year to complete.

Textual material covers economic readiness of nations and blocks of

nations to wage war and US ability to retaliate. Special emphasis is placed on the interdependence of military, economic, political and psychological factors in determining national might.

At present over 3600 persons are enrolled. Many companies reportedly recommend the course as part of their executive development programs. There is no charge for the course. ■

Unmanned Sub Views Ocean Floor

WASHINGTON—Within the next few weeks, the Navy will unveil its latest research vehicle—an unmanned submarine that is operated by remote control from a mother ship with TV monitors.

At the outset, the Navy will give no official indication of the size or appearance of the sub. Extensive testing has already been conducted in the Pacific Ocean.

The sub will be used to explore the depths of the oceans—a program that is getting top priority as the US moves into the nuclear submarine age.

The far ranging, deep diving nuclear subs make it important to obtain accurate mapping and ocean currrent data. Right now, very little is known about the vast expanses of the ocean floors.

The Navy still has an interest in the aluminum research submarine proposed by Reynolds Metals Company. At present, however, the project is pretty much at a standstill (*PE—Mar 9, p 25*). ■

Amateurs Trained for Political Action

CHICAGO—The Hotpoint Div of GE has joined the growing number of companies who offer their employes a training program in "practical politics." Object is to teach employes how political parties function, and how they, as individuals, can become active in the party of their choice and influence its policies.

Trainees will attend 3 intensive 2-hour workshops during August and September. At present 20 classroom groups with 20 persons in each group are enrolled, but the company hopes to expand its program so that eventually thousands of employes can attend similar sessions. ■

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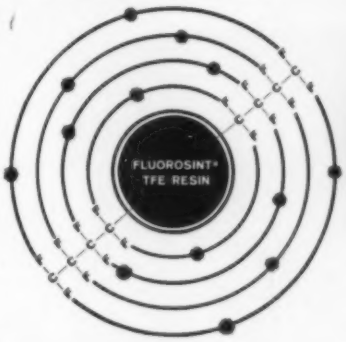

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Chemical and electrical properties similar to unmodified Teflon (TFE).

Where to use it:

For mechanical parts including bearings, bushings, sliding and wear surfaces—wherever low surface friction or distortion under load at high temperatures is a problem.

For chemical parts, wherever excellent chemical resistance and other outstanding advantages are indicated, such as parts operating in corrosive conditions or under water.

For electrical parts, where its heat and moisture resistance and low thermal expansion make it ideal for stand-off insulation or insulating wear parts.

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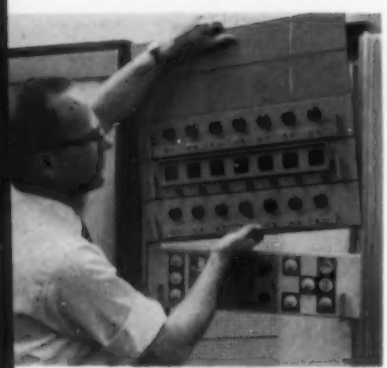
TRENDS in appearance design...

String layout and a two-dimensional, articulated model of an operator help to demonstrate strong and weak points in proposed design of data recorder.

Quarter-scale model of recorder mounted on a single rack.

Quarter-scale model of data recorder mounted on double rack.

Fitting amplifier and oscilloscope sections of data recorder into place on full-scale model.



Full-scale model of tape transport installed

A SERIES OF MODELS . . . marked the development of the new Ampex Corp data recorder, which started with consumer surveys, service reports, and field trips by the industrial design staff. The first "blue-sky" sketches were studied for appearance and function with the engineering group. The control panel was then laid out on pegboard with colored knitting yarn, and checked against a two-dimensional, articulated model of an average-sized operator.

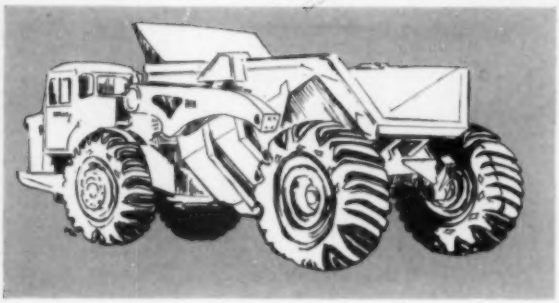
The string-and-pegboard layout revealed problems immediately. The tape transport occupied the top of the panel, the controls the bottom—all scaled to a standard 19-in. wide rack. However, recording and monitoring required more panel space. Also, uncomfortable operator positions were required to reach various controls and read indicators—some only 6 or 8 in. off the floor. Reversing the arrangement only made placement of tape reels more difficult.

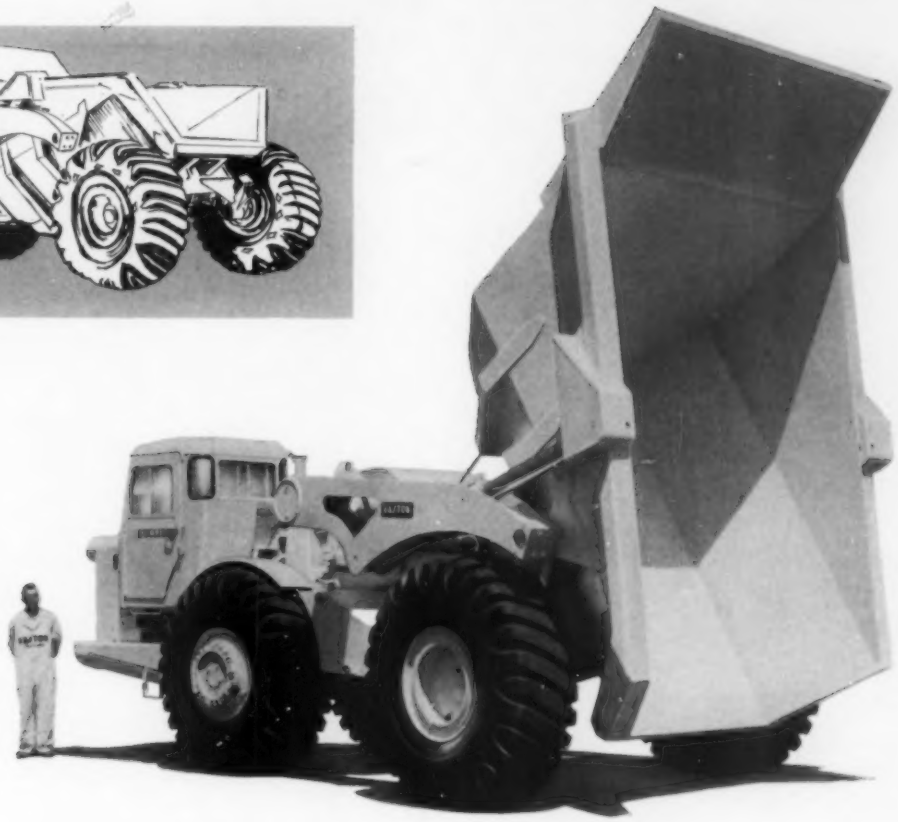
Putting controls and tape transport side-by-side provided the answer. It also added storage room for extra tape and accessories. Ampex engineers then built a structural model, to determine production feasibility and test structural strength.

Afterwards, a quarter-scale model was made. This proved out advisability of building the machine in a double rack, but it also indicated the advantages of interchangeability—the recorder is also available in a single rack.

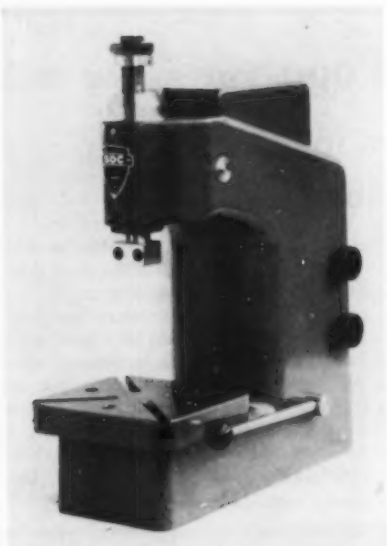
A final, full-scale model permitted experiments with color schemes. Checkouts of sizes, shapes and arrangements of controls were also possible.

Operator checkout of complete full-scale model of data recorder.





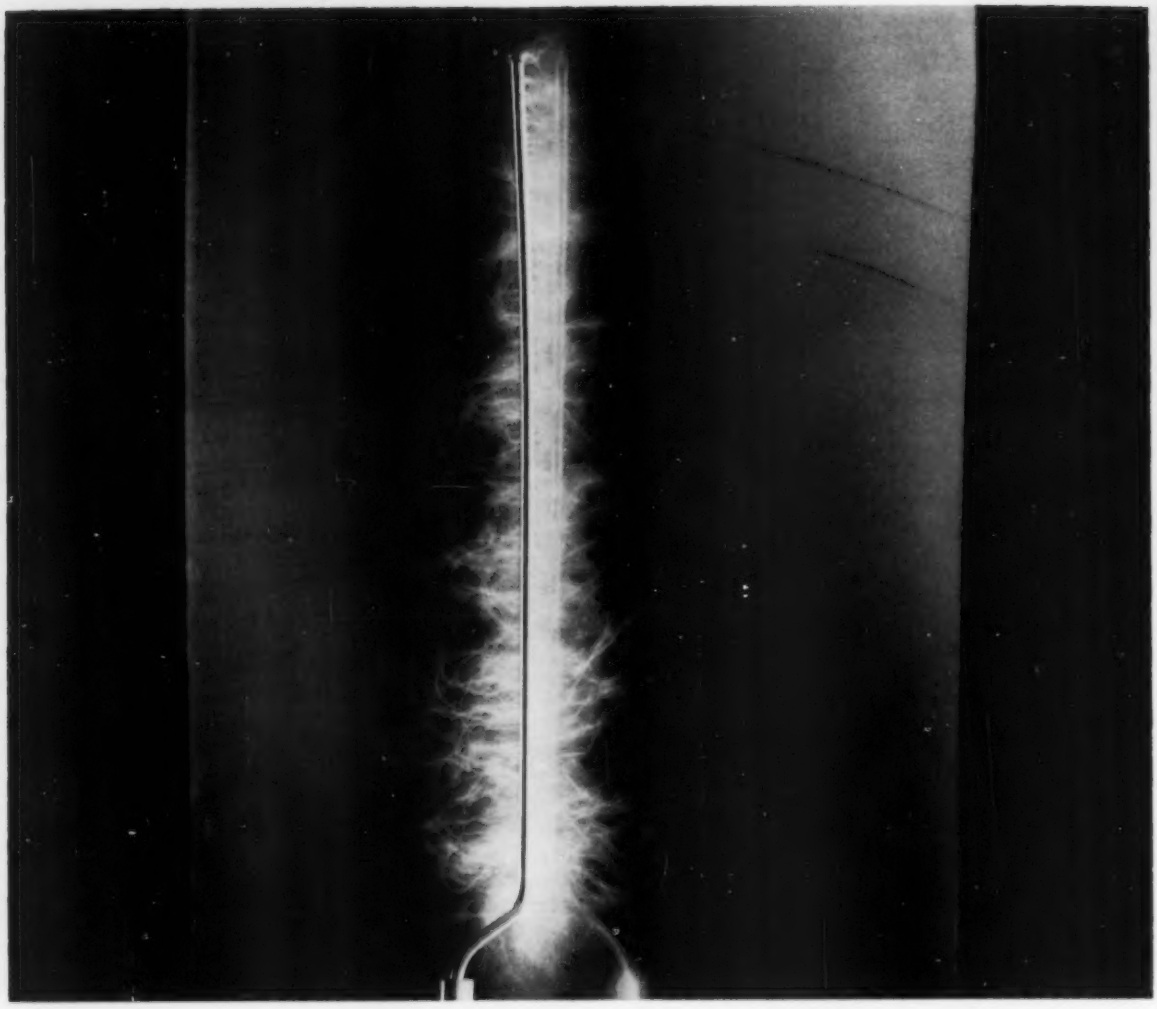
Functional look of this 22-ton rear dump trailer is the work of its designer, George D Fraunfelder, vice-president of engineering, Easton Car & Construction Co. As body is lifted to dump position, wheelbase shortens. This variable length makes possible narower radius turns, important in many construction sites.



Pneumatically operated press has exactness of form that seems to express its function; the forming, stamping, riveting, spindling of watch parts. Developed by Societe Ornanaise de Constructions Mecaniques, Ornans, France.

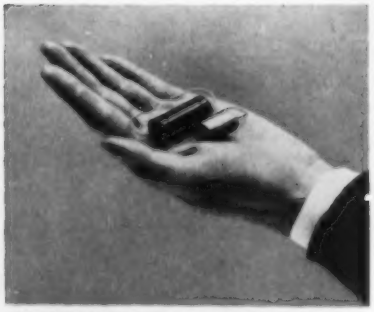
Integral rest for handset gives sculptured look to hotel telephone by Siemens & Halske AG, Munich, Germany. Figures 1 to 8 are for dialing directly to internal hotel staff. Outside calls are made by first dialing 9 or 0.

Electric golf putter automatically returns ball to various distances according to knob adjustment. Made by Swank, Inc, Attleboro, Mass.



MYLAR® has a dielectric strength of 4,000 volts per mil

Can the unique combination of properties found in "Mylar" help you solve your design problems?



High dielectric strength helps cut capacitor size. Tough, thin "Mylar" with a dielectric strength of 4,000 volts per mil for 1 mil film (per ASTM-D-149) permits capacitor manufacturers to reduce size of finished unit . . . improve performance and reliability.

"Mylar"* polyester film is a tough, flexible engineering material. In addition to its outstanding dielectric strength, "Mylar" has an average tensile strength of 20,000 psi, withstands temperature extremes (-60° to 150° C.) . . . resists most chemicals and moisture.

On an area basis, tough, thin "Mylar" often *costs less* than heavier, conventional materials. "Mylar" can be laminated, embossed and metalized, punched or coated. The film won't embrittle with age. "Mylar" is available in roll or sheet form in a wide range of gauges.

Find out how the *combination of properties* in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write for our booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room P-8, Wilmington 98, Del.

*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

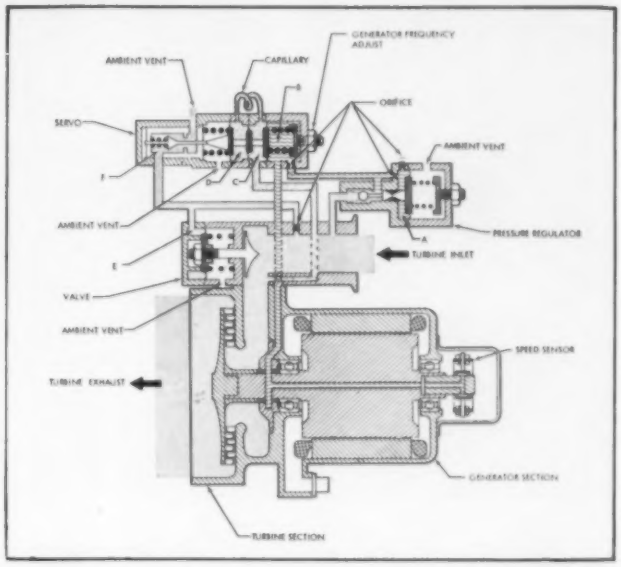
DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT MYLAR® POLYESTER FILM

SIGNIFICANT COMPONENTS MATERIALS PROCESSES

W-point socket set screw . . .
is constructed so that cone point contacts engaged work before cup edge, which is also integral part of set screw. Said to be superior to cup point socket set screws now in use and to provide 30% more backout torque, 50% more resistance to rotary slippage and 50% more resistance to vibration. Fastener is reported to track evenly and with a well-defined, even groove, resulting in positive frictional contact of both flanks of cup with engaged work. W-point, acting as fixed point, is said to prevent oscillation of cup edge and minimize tipping effect of key tightening. **Parker-Kalon, Div of General American Transportation Corp, Clifton, NJ.**

Circle 101, Reader Service Card



Centrifugal force lifts poppets in speed sensor . . .
when preset shaft speed is reached. Resulting air bleed provides pneumatic signal for regulation of various types of shaft-based power and control systems. Said to exhibit no frictional limitations or zero calibration shift. Present model, which was designed for use with small air turbine generator (system shown above) requires 20 in. Hg inlet pressure and at 24,000 rpm outlet pressures reaches same point. Cracking point for this unit is 23,000 rpm, max overspeed, 30,500 rpm. Repeatability is ±2%, full scale. For use to 300 F. Priced under $100; delivery, 90 days. More complex applications are possible. **Airesearch Mfg Div, Garrett Corp, 402 S 36th St, Phoenix, Ariz.**

Circle 103, Reader Service Card

Voltage-sensitive controller . . .
is said to operate like grid-controlled gas rectifier, being activated when input voltage reaches predetermined value and holding until input voltage is removed. Developed for use as storage battery charging controller (controller made by Marquette Mfg Co Inc, 307 E Hennepin, Minneapolis 14) device is reported to have broad applications in low voltage circuits as electronic switch or phase shift controller. In original application, controller permits operator to make connections, turn on switch and leave it unattended. Battery charges to predetermined level and then charging rate is reduced to predetermined minimum. Charger is controlled by battery and temperature conditions. Other typical applications include pulse switches, transient or peak voltage detector, and other more complex switching circuits. Triggger device is less than $30 in medium quantities; 4 to 6 wk delivery. **American Electronics Co, 2801 37th Ave NE, Minneapolis 18.**

Circle 102, Reader Service Card

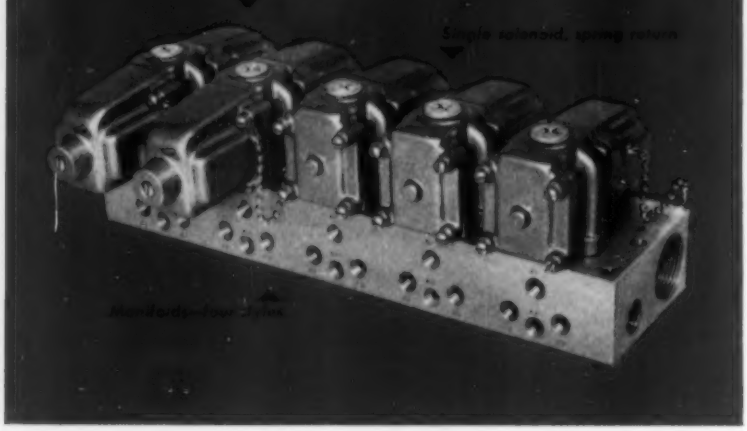
High-hardness welding alloys . . .
retain hardness at high temperatures when applied to selected areas of commercial aluminum products. At 500 F, alloys are reported to provide areas four times as hard as commercial aluminum piston compositions at this temperature. One of four aluminum alloys, now being tested, provides Brinell hardness of 250 at room temperature. Alloys available for experimental use; also in pistons and sheaves with zones of hard welding metal. **Aluminum Co of America, Room 783, Alcoa Bldg, Pittsburgh 19.**

Circle 104, Reader Service Card

Ultrasonic measurement . . .
of liquid level uses solid metal acoustic wave guides to derive its information, essentially ignoring or cancelling effect of liquid and its properties on accuracy of level measurement. Level is measured continuously in liquid nitrogen, many slurries, thick oils, fused salts, molten metals and other fluids. Almost any fluid pressure or temperature can be accommodated. Output is either digital or continuous and adaptable to recording and control, proportioning and blending. **General Ultrasonics, 6 Tobey Rd, Bloomfield, Conn.**

Circle 105, Reader Service Card

NOW A COMPLETE FAMILY OF SMALL AIR VALVES, MANIFOLDS, ACCESSORIES



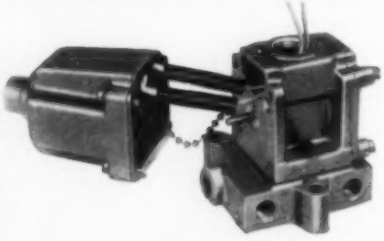
NUMATICS' New SA Junior Series

You've found it! . . . the answer to *all* your small air valve requirements. It's the new *SA Junior* Series . . . Numatics' small, precision-built, heavy duty family of valves and manifolds. Two valve types (above), many model varieties . . . three different sub-plates . . . three operator options and four styles of manifolds to provide application versatility unlimited.

SA Junior, what's more, gives you *quality* throughout . . . Numatics' famed patented lapped spool-floating sleeve action . . . corrosion-resistant aluminum body . . . continuously rated, heavy duty solenoids . . . J. I. C. conformance . . . all this plus a ruggedness and reliability to handle 60% of all your air jobs at an average 40% reduction in air valve costs. Send for a catalog today!

"Solenoid Capsule" Design—Another NUMATICS' FIRST!

Typical of SA Junior quality and design ingenuity is the unique, new "Solenoid Capsule" . . . a Numatics' *exclusive*. Solenoid and cover are a self-contained, J. I. C. approved assembly which eliminates loose parts when the solenoid cover is removed.



NUMATICS, Inc.
HIGHLAND, MICHIGAN

SIGNIFICANT COMPONENTS
MATERIALS
PROCESSES . . .

Lightweight vibrator . . .

weighs 4½ oz, yet retains power and strength of 11-oz predecessor. Unit is fitted with replaceable jet for air economy. Vibration is generated by rolling ball driven in orbit on replaceable raceways of hardened high-alloy steel, precision ground. Said to be safe in explosive atmospheres and usable in high ambient temperatures that preclude use of electric vibrators. May be obtained in natural aluminum finish at no extra cost. Special lug allows mounting in any position with single bolt. Vibrator will handle bins with 4 cu ft storage capacity. Air consumption is 3 cfm, free air at 80 psi. Operates on 5 psi min. Priced at $13.20. All-brass regulator, which costs $3.50, permits stepless control of frequency from zero to more than 25,000 cpm. **Martin Engineering Co, Neponset, Ill.**

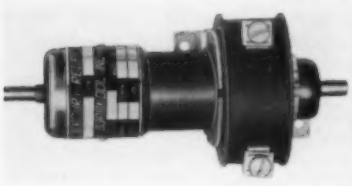
Circle 106, Reader Service Card

Engine control . . .

monitors speed in range of 500 to 5000 rpm at temperatures of —65 to 250 F with accuracy within ½% of speed setting. Device is essentially flyball-type governor and contains flyweights resisted by calibrated spring force. Response to engine rotation results from accuracy with which flyweights are calibrated. Centrifugal force becomes a thrust on actuator that operates two snap-action electrical switches. Life expectancy is over 2000 hr. When more than two switches are desired, or when settings are in different

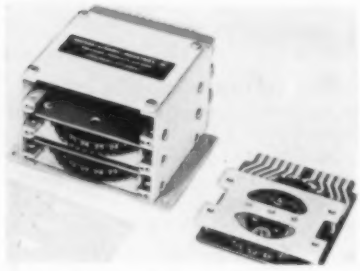
speed ranges, two monitors can be coupled in tandem. Meets requirements of MIL-E-5009A. Can be calibrated to meet customer requirements for such applications as engine starting cycle control, ignition and ignition cutoff, engine starter cut-off, clutch control, overspeed and underspeed protection. Production units are available. **AC Spark Plug, Electronics Div of General Motors, Milwaukee 1.**

Circle 107, Reader Service Card



Mercury-to-metal contacts . . . are offered on 60 and 100 amp hydrogen arc-quenched heavy load carrying contactors. Carry 6.6 kw and 10 kw loads, with combinations for every requirement, such as normally open or normally closed contacts and any coil voltage, dc or ac. Said to be suitable for tungsten lighting or switching of heavy motor loads. 60-amp contactors are priced from $8.50; 100-amp units, from $19. **Durakool Inc, Elkhart, Ind.**

Circle 108, Reader Service Card



Miniature rotary switch . . . mounts in ½ in. of panel space, which is ¼ that needed by conventional shaft-type knob-operated switches. Printed circuit modular switch units can be removed and replaced without unsoldering, disassembling or wire removing. Modular bank of 25 switches can contain up to 500 separate switching circuits. Switching circuits are actuated manually by rotary wheel giving visual digital indication of switch position. 10-position model is ⅜ x 1¾ in.; 20-position model, ⅜ x 2¼ in. **Chicago Dynamic Industries Inc, Precision Products Div, 1725 Diversey Blvd, Chicago 14.**

Circle 109, Reader Service Card

Laminated polyester film . . . is reported to be flexible, to have high mechanical strength, good electrical properties, high heat resistance, and to be resist-

(Continued on page 42)

GARLOCK MECHANICAL SEALS

Easy to install—Garlock's PK MECHANIPAK* is self-contained—no parts to "put together." Rotating portion simply slides onto shaft; stationary portion positions quickly into counterbore of gland.

Easy to maintain—Once Garlock's PK MECHANIPAK is installed, further adjustment is unnecessary. No parts of the seal move on the shaft or sleeve, eliminating wear on shaft . . . spring in seal maintains contact between sealing faces.

Easily cuts costs—Garlock's PK MECHANIPAK is designed to reduce maintenance and downtime, thus offers many dollar-saving benefits.

Available in shaft sizes from 3/8" to 3" . . . will operate at temperatures to 212°F, pressures to 150 psi, shaft speeds to 2000 fpm. PK MECHANIPAK Seals are another important part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Find out more from your local Garlock representative, or write for Catalog AD-150.

*Registered Trademark

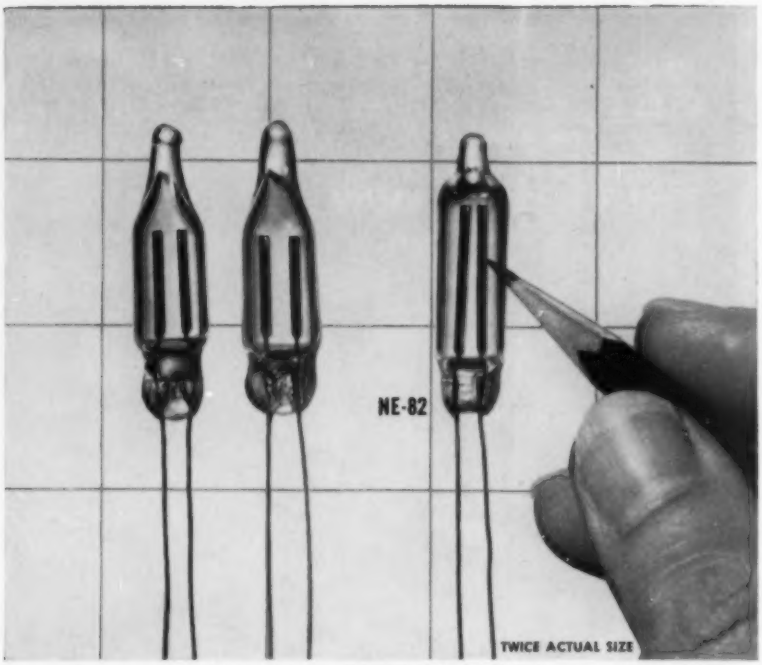
THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

For Prompt Service, contact one of our 26 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Canadian Division: The Garlock Packing Co. of Canada Ltd., Plastics Division: United States Gasket Company



New NE-82 shown with other G-E Glow Lamps

LONGER ELECTRODES on G-E NE-82 Glow Lamp permit up to 5 times higher current loadings

(up to 1.5 m.a.)

The General Electric NE-82 Glow Lamp has controlled characteristics and was specifically engineered for higher current loadings—up to five times higher than most other circuit component glow lamps. Its lengthened electrodes insure a longer period of stable operation at higher loadings than glow lamps having shorter electrodes.

Special techniques developed by General Electric bring the G-E NE-82 to a condition of stability; this helps the NE-82 provide uniform performance within established, predetermined limits. The leads of the G-E NE-82 have been plated for soldering ease. The NE-82 also uses the new "formed tip" construction for minimum over-all length.

DIRECT CURRENT CHARACTERISTICS

Starting Volts	62-78-Volts d-c
Operating Volts (up to 1.5 m.a.)	50-60-Volts d-c
Extinguishing Volts (in series with .25 megohms or more)	50-Volts d-c
Design Current	1.5 m.a.
Life—Change in Starting and Operating Volts at 1.5 m.a.	+5-Volts in 2,000 hours.

Select the General Electric Glow Lamp best suited for your circuit requirements. For further information write for "Glow Lamps as Circuit Components", General Electric Co., Miniature Lamp Dept. M-903, Nela Park, Cleveland 12, O.

Progress Is Our Most Important Product

GENERAL ELECTRIC

SIGNIFICANT COMPONENTS MATERIALS PROCESSES . . .

(Continued from page 41)

ant to delamination. Sheet consists of two plys of 0.010-in.-thick polyester film, laminated with a special bonding agent. Resultant laminate can be cold-formed with wooden molds or punched into variety of shapes and forms. Material is also resistant to Freon 22 in sealed systems where no moisture is present. Sheet is uniform in thickness, translucent, smooth and free from wrinkles or voids. Particularly adaptable to applications requiring formation of simple shapes that are tough, flexible and hold their form. **Mica Insulator, Div of Minnesota Mining & Mfg Co, Schenectady 1.**

Circle 110, Reader Service Card

Split-package digitizer . . .

for systems requiring precision of optical shaft-angle encoding but having limited space at point of angle measurement, consists of two separate packages, an optical-mechanical converter (25 in^3) and an amplifier assembly (37 in^3). Cable up to 3 ft long carries 13-digit reading signals from converter head at point of measurement to 13 separate amplifier channels. Angle reading is at rate of 100 digital words per sec, to accuracy of ± 2.5 min. Separately-packaged reading head, secured on synchro mount from size 23 to 35, contains built-in calibration cell for monitoring encoder operation and for mechanical alignment at assembly. Electrical output of each amplifier channel is 5 v for 'one' and less than 50 milliv for 'zero'. Angular reading accuracy maintained from —65 to 165 F and 95% relative humidities. **Dychro Corp, 12 Centre Ave, Newton 58, Mass.**

Circle 111, Reader Service Card

Subminiature speed reducer . . .

is available in 34 different ratios from 1:1 to 27:1. Over 400 higher ratios up to 531,441:1 are available in longer units. Units handle 16 in.-oz torque at low speed shaft. Speeds up to 360 rpm on high

speed shaft are said to be reached without excessive wear. Hobbed, smooth-running spur gears are 96 pitch and 20° pressure angle gears are case-hardened steel. Hardened and polished input shaft, output shaft and countershafts run in sintered nickel-silver bearing surfaces of case itself. Gears are permanently lubricated. Mount in any position with shaft heights at ¾ or ½ in. Weigh 2¾ oz. **Metron Instrument Co, 432 Lincoln St, Denver 3.**

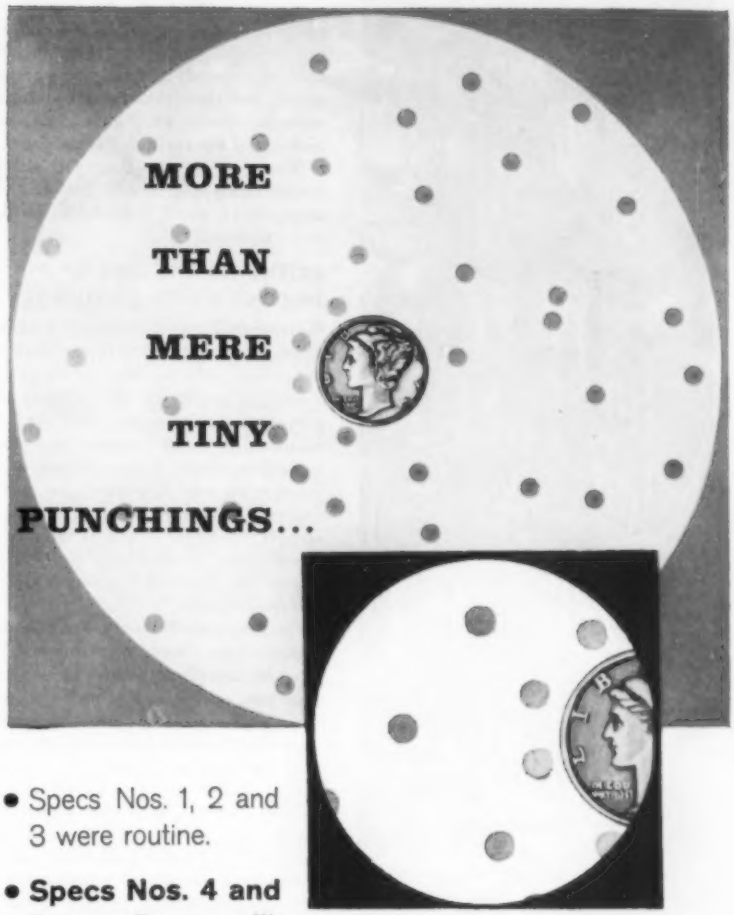
Circle 112, Reader Service Card

Control system transducer . . . converts dc voltage or milliamp signal to pneumatic control signal with linearity and hysteresis deviations of less than 1% even at low ranges. Unit responds to input changes of 0.05 v, has dead time of 0.02 sec and full range time of 1.25 sec. Adjustment is provided for input ranges from 0.25 to 2.5 v to 1 to 10 v and a series of output ranges between 0 and 1.5 psig to 3 to 15 psig. Operates from 117 v ac line voltage and uses supply pressure 1.2 times max output pressure. Voltage signal from feedback transmitter sensing output pressure of unit is compared with input signal. Unless signals are equal, closed loop servo system makes necessary corrections until output air pressure is proportional to input signal. Suitable for ambient temperatures of 0 to 150 F. **Associated Control Equipment Inc, PO Box 136, 853 Fourth Ave, Coraopolis, Penna.**

Circle 113, Reader Service Card

Pressure gage accuracy . . . to within ¼ of 1% ± max dial reading over entire range is reported for line of instruments made in all standard pressure ranges and in compound and vacuum types. New dial, in which inner arc shows major markings and outer arc fine graduations, permits accurate readings. Further reading accuracy is said to be facilitated by three methods of reading: a twin-tip pointer with one tip directly below the other, which line up so that they appear as one; a mirror dial (pictured) that reflects pointer and when pointer and reflection

(Continued on page 44)



- Specs Nos. 1, 2 and 3 were routine.
- **Specs Nos. 4 and 5 were "unusual".**

What you are looking at are specimen holders for an electronic microscope. They're so small that it takes about 40 to cover a dime. Specifications as to kind of metal, diameter of wire and mesh might be considered routine. It's what we did with the cloth before punching and how we treated the punchings that are important. Spec No. 4 especially tested our manufacturing skills. No. 5 called for special cleaning.

We started with NEWARK Stainless Steel 200 x 200 Mesh Cloth woven with 0.0021 inch diameter wire. Cloth thickness was 0.0042 inches. Then we rolled or calendered the cloth very carefully to 0.0025 inch thickness. After clean-cut punching, we cleaned and passivated the pieces in dilute nitric acid, imparting to them an almost surgical cleanliness...a cleanliness which was retained through the packing. The discs had to be kept free of foreign matter.

As pointed out above, the cloth itself is not uncommon but the rolling and treatment were somewhat unusual. The skill in handling and quality of work typified by this job suggests the skill and quality of work available to you for any "wire cloth" insert project you have in mind. Incidentally, much of our work is in preparing "punchings" in all diameters in single pieces, in segments, or in sectors.

NEWARK for ACCURACY

Newark Wire Cloth COMPANY

351 Verona Avenue • Newark 4, New Jersey

CIRCLE NO. 43 READER SERVICE CARD

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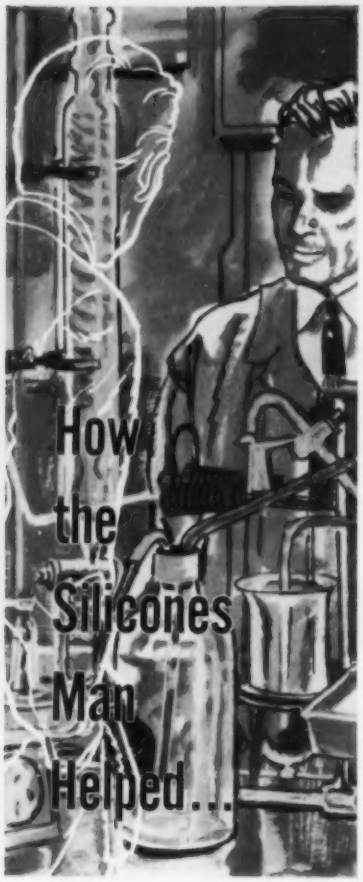


GREATER HEAT AND WEATHER STABILITY FOR COLD-BLENDED METALLIC PAINTS

Manufacturers of automotive components—manifolds mufflers, tailpipes—can lengthen the life of parts subject to wetting and oxidation with a silicone resin specially designed by UNION CARBIDE. Industrial stacks, ducts, vents, ovens, conveyors, and other equipment get longer-lasting protection. Many other producers and users of metal products will find benefits from metallic-pigmented paints made with the new silicone resin.

When used for cold-blending with alkyd, melamine, and acrylic resins, the new silicone product gives coatings greatly increased thermal stability and weather resistance. Blended with aluminum and other metallic pigments, the resin mixtures supply all the desirable high-temperature properties of straight silicones at a lower cost.

Paint formulators will find numerous other advantages by using this silicone resin. Its compatibility with organic systems is superior to resins traditionally employed. The inherent film toughness and adhesiveness of organics is retained—blends are easy to prepare, apply, and cure. Substantial savings in materials result, since only low concentrations of the resin are required.

The new UNION CARBIDE silicone product can also be cold-blended with organics to meet applicable military specifications.

EXTENDING THE USES OF SILICONE WATER REPELLENTS

Water repellents formulated with silicones are now standard in specifications for above-grade masonry by many engineers and architects. The silicone resin penetrates into pores and crevices, eliminating water seepage and checking efflorescence. A special type of silicone resin was developed for use on concrete highways, bridges, dams and airport runways, which is effective in minimizing the cracking and spalling caused by alternate freezing and thawing conditions.

Cooperative efforts of asbestos shingle manufacturers and the Silicones Man have resulted in another silicone water repellent that keeps asbestos shingles clean and colorful, despite the weather. The silicone resin, by lining tiny cracks and crevices in the asbestos composition, prevents entry of rain-borne dirt and other soiling particles. Foreign material that settles on the surfaces is rinsed away by the rain. Since the silicone is colorless and transparent, the shingles retain their original color and appearance.

CAR OWNERS (AND THEIR WIVES) WILL BE GLAD TO HEAR ABOUT THIS

Here's what the operators of a certain government transportation unit do to eliminate hard-to-find squeaks in their fleets of vehicles: They apply just a bit of silicone lubricant to the rubber weather stripping and fan belts. This not only cuts out squeaks for several months, it restores flexibility to the rubber. Despite the weather—rain, heat or cold—it won't turn sticky or messy . . . doesn't harm paint or metal.

The Silicones Man is accustomed to helping solve problems like these . . . and he may be able to help you, too. For background information on these and other applications, write Dept. HP-0904, Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Toronto 7.

UNION CARBIDE TRADE-MARK

SILICONES

The term "Union Carbide" is a registered trade-mark of Union Carbide Corporation.

SIGNIFICANT COMPONENTS MATERIALS PROCESSES . . .

(Continued from page 43)

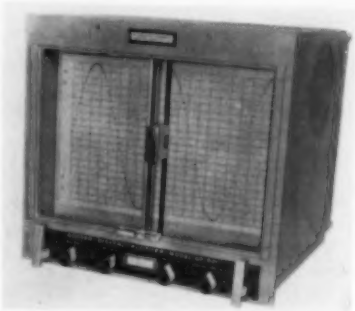
are in alignment, reading is true; clear Plexiglas insert placed along outer edge of dial and over fine graduations optically raises graduations so that they line up visually with level of pointer, permitting correct reading even if read at an angle. Dial sizes 4½, 6 and 8 in. **Marsh Instrument Co, Skokie, Ill.**

Circle 114, Reader Service Card

Electrostatic paint system . . .

utilizes an array of variable-speed, centrifugal atomizers charged at potential of 140,000 v. System employs electrical interaction between rotary atomizers, effecting electrostatic deflection that controls width and density of one or more fan-shaped spray patterns. Said to penetrate cavities of articles having irregular surface contours. Painting equipment can spray single color and also blend solid single colors for multicolor effects. **Ionic Electrostatic Corp, Garfield, NJ.**

Circle 115, Reader Service Card



Digital plotter . . .

consists of two high-speed servo systems that position a printing mechanism according to binary coded x and y input signals, two digital-to-analog converters, one each for x and y signals, a plot and computer acknowledge circuit and power supplies. Plot and computer acknowledge circuit actuates printing solenoids after printing mechanism has been properly positioned by x and y servo systems. Basic design on converter is for parallel, simultaneous x and y input formals; however, serial may be used by incorporating relay matrix memory in converter. Plots random input with 0.1% accuracy at 2 points per sec; with 0.2% accuracy at 3 points per sec. Can print 1 to 6 different symbols. Slewing speed is 50 in. per sec. Size of unit, 19 x 17 x 22 in. Operates on 115 v, 60 cps, 250 w. **Gerber Scientific Instrument Co, 89 Spruce St, Hartford, Conn.**

Circle 116, Reader Service Card

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

AMP, Inc. 32

Barksdale Valves 26
Berry Hydraulics Div., Oliver Tyrone Corp. 33
Briggs & Stratton Corp. .....4th Cover

DeLaval Steam Turbine Co. 15
du Pont de Nemours & Co. (Inc.), E.I., Film Dept. 38

Eastman Kodak Co., Special Products Div. 28
Enjay Co., Inc. 10
Equitable Engineering Co. 34

Faber-Castell Pencil Co., Inc., A. W. .....3rd Cover

Garlock Packing Co. 41
General Electric Co., Apparatus Dept. 9
General Electric Co., Miniature Lamp Div. 42
Great Lakes Steel Div., National Steel Corp. 24-25

International Nickel Co. Inc. ....2nd Cover

Koppers Co. Inc., Plastics Div. 5

Microbeads, Inc. 33
Micro Switch Div., Minneapolis-Honeywell Regulator Co. 12
Minnesota Mining & Mfg. Co., Chemical Products Div. 18

Newark Wire Cloth Co. 43
Numatics, Inc. 40

Phillips Chemical Co. 16-17
Plan Hold Corp. 6
Polymer Corp. of Pennsylvania 35

Stratoflo Products, Inc. 33

Union Carbide Corp., Silicones Div. ... 44

Vulcan Electric Co. 46

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Chicago 11 . . . Mid-Western Adv. Sales Manager, A. E. Meanor; R. W. Bruley, L. Anderson, 520 N. Michigan Ave., Mohawk 4-5800

Cleveland 13 . . . A. F. Tischer, 1164 Illuminating Bldg., 55 Public Square, Superior 1-7000

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Detroit 26 . . . P. B. Robinson, 856 Penobscot Bldg., Woodward 2-1793

Los Angeles 17 . . . Robert Obenour, 1125 West 6th St., Madison 6-9351

New York 36 . . . B. K. Adams, R. G. Wallace, 500 Fifth Ave., Oxford 5-5959

Philadelphia 3 . . . D. G. Jones, K. S. Willadsen, 6 Penn Center Plaza, Locust 8-4330

Pittsburgh 22 . . . C. F. Leveroni, 1111 Oliver Bldg., Express 1-1314

St. Louis 8 . . . R. W. Bruley, 3615 Olive St., Continental Bldg., Jefferson 5-4867

San Francisco 4 . . . W. C. Woolston, 68 Post St., Douglas 2-4600

NEW LITERATURE

Three Dictionaries for Outer Space

ARMAND SPITZ and FRANK GAYNOR, Dictionary of Astronomy & Astronautics. Philosophical Library Inc, 15 E 40th St, New York 16. 5¾ x 8¼, 439 pp. $6.

FRANK GAYNOR, Concise Dictionary of Science. Philosophical Library Inc, 15 E 40th St, New York 16. 5¾ x 8½, 540 pp. $10.

GRAYSON MERRILL, Editor, Dictionary of Guided Missiles & Space Flight. D Van Nostrand Co, Inc, Princeton, NJ. 7½ x 10¼, 688 pp. $17.50.

Three dictionaries with an eye on the missile field seem to have taken their cue from their subject matter. The first two have cut definitions to a bare minimum 1 to 3 lines in many cases. This might be expected to reduce weight and space. It does help. But its major effect is to permit use of larger type and more white space in volumes of fairly conventional size. The brief definitions can serve as brief reminders and refreshers for those who already understand the terms covered; but may seem somewhat inadequate to the uninitiate.

The third dictionary, Guided Missiles and Space Flight, is the heftiest tome of the three. It also features good type and has longer–but unfortunately also far more complex–definitions. It errs, in other words, in the opposite direction.

Incidentally, there is surprisingly little duplication among the three. Only one, for instance, defines magnetohydrodynamics, and only two magnetostriction. –ARG

Two On Organizing Humans

R M STOGDILL, Individual Behavior and Group Achievements. Oxford University Press, 417 Fifth Ave, New York 16. 352 pp, 5¾ x 8½. $5.

KEITH DAVIS and W G SCOTT, Readings in Human Relations. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36. 473 pp, 6¼ x 9¼. $6.50.

To a large extent, these two books represent, respectively, the two primary aspects of any complex subject concerned with humans and their works: theory and practice. Indicative of this is the subtitle of Stogdill's book, "A Theory, The Experimental Evidence." The theory is an attempt to provide a basis for understanding what happens both to the individuals in a group and to the group itself when they operate effectively. This book, which is highly specialized in concept and treatment, may well provide the engineering administrator with a whole new approach to his job of developing and guiding engineering groups to greater productivity and efficiency.

"Readings in Human Relations" consists of 63 articles and selections from American and European periodicals and books in the fields of sociology, psychology, philosophy, management and labor relations and economics. In each field selections are arranged from general concepts to more specific observations and applications. The well-known article by Davis, "Making Constructive Use of Office Grapevine", is included. –JK

RESEARCH AND DEVELOPMENT FACILITIES–Brochure, 16 pp. Depicts, in text and pictures, activities of organization in practical engineering, design, testing and precision manufacture. Raymond Engineering Laboratory Inc, Smith St, Middletown, Conn.

Circle 121, Reader Service Card

LUNAR GEOGRAPHY–Map charts geography of visible side of moon, enabling location of key points of lunar terrain. General Electric Co, Dept 4C, 3198 Chestnut St, Philadelphia 4.

Circle 122, Reader Service Card

TITANIUM–Fact file, 24 pp. Contains sections on high-temperature performance, corrosion resistance, erosion resistance, mechanical properties, metallurgy, machining, fabrication, welding, testing, quality control, along with list of alloys and mill shapes available. Mallory-Sharon Metals Corp, Niles, Ohio.

Circle 123, Reader Service Card

INDUSTRIAL NICKEL PLATING – Booklet, 20 pp. Presents properties, fabrication possibilities, and both general and specific applications. In addition, it features extensive corrosion data taken from actual plant tests. International Nickel Co Inc, 67 Wall St, New York 5.

Circle 124, Reader Service Card

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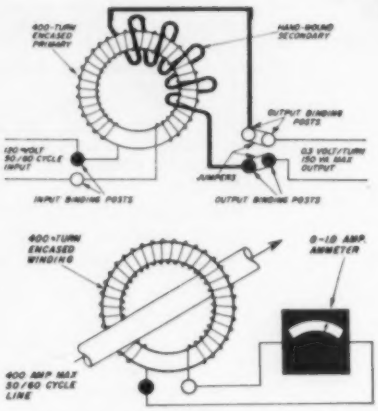
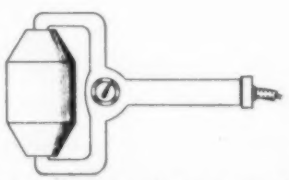


Choose your own voltage

A transformer kit that can serve as a multiple source of output voltages, or be hooked up to a O-1 amp ammeter for measuring currents up to 400 amp with an accuracy of 1% at 60 cycles, is offered by Superior Electric Co, Bristol, Conn. It consists simply of a toroidal coil in a plastic case provided with 5-way binding posts integrally mounted on ¾-in. centers. It has an output rating of 120v, 50/60 cycles single phase, and an output rating of 150 VA. The desired output is obtained by winding the coil (see diagram above) with a specified number of turns of wire. This number is obtained by dividing the desired output voltage (plus 25% allowance for internal transformer drop) by 0.3 (the volt/turn ratio of the unit).

The Flexiformer is priced at $22 (shipping weight: 6 lb. 4 oz).

Try this one on your wife



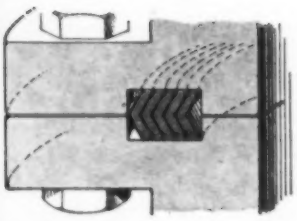
Paint roller? Rolling pin? Not at all. It's the latest idea in electric irons—and not a bad one at that. Invented by a Munich engineer, it's designed to roll smoothly over even the most recalcitrant shirts; should eliminate much lifting; and, by virtue of its conical shape, should be able to get into small areas like shoulders and pockets.

Analogs for anyone

An analog computer kit now comes on the market to join the several digitals already available. Called *Calculo*, it's powered by flashlight batteries, "can be assembled in 2 hr with screwdriver and pliers—no soldering"; and will solve such problems as: "What is the range of a projectile whose initial velocity is 1200 fps at an angle of 40° with the ground?" Best feature of the new kit is the 36-p instruction manual that comes with it. Besides telling how to solve specific problems, it gives many of the basic useful formulas (Ohm's Law, arithmetic progressions, inductive reactance, also volume of cylinder, oblate spheroid, torus, and cone).

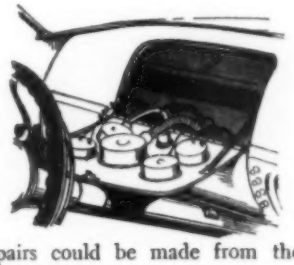
The kit itself, containing blank dials, ammeter, electrical parts, and mounting box, is priced at $16.95. From Science Materials Center, 59 Fourth Ave, New York 3.

Why Don't They RESEARCH and DEVELOP . . .



. . . a gasket, of the spiral-wound metallic type, suitable for applications at working temperatures up to 1200 F. These gaskets are commonly used to seal the flanged joint between two pipes. They consist of a crimped metal strip wound spirally from inside to outside with an asbestos filler cushion between each layer. But above 1000 F the filler breaks down and the metal loses its spring qualities. A gasket with a carborundum filler material might withstand higher service temperatures.—J T MULLER

. . . gas tanks for automobiles and airplanes that will not allow the contents to spill and catch fire in the event of a crash. A great many minor accidents become major accidents when the gas tank is ruptured and ignited by a spark or hot engine part. Perhaps the tank could be made of a thick flexible material that would not rupture when crushed. Or a chemical could be released in the tanks just before impact to make the fuel non-flammable by changing its physical or chemical characteristics. If applied to aircraft, this inerting system must be foolproof; it must work only in the event of accident.—H TURENCHALK



. . . hinged access panels on automobile dash boards. At present, when it is necessary to make repairs behind the dash panel, the mechanic must lie in an uncomfortable position and fight his way through a maze of wires, cables, and support brackets. If the instrument cluster were mounted on a hinged panel, repairs could be made from the front . . . quicker and easier—R PAULSON

. . . an indicator for flashlight cells to show performance capability. Dry batteries have only a limited shelf life. A litmus-paper-style indicator under a transparent window on the side of the battery would change color as it aged. Comparing color with a chart on the case would tell battery condition. Or a coated sheet of material that changed color as the battery aged could be included with each carton of batteries.—R MARIE

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worth-while paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who may have a fresh viewpoint or more time for necessary R & D. We will pay $10 for each one accepted.

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5	12	19	26	33	40	47	54	61	68	75	82	89	96	
6	13	20	27	34	41	48	55	62	69	76	83	90	97	
7	14	21	28	35	42	49	56	63	70	77	84	91	98	

SIGNIFICANT PARTS and NEW LITERATURE

101	106	111	116	121	126	131	136	141	146
102	107	112	117	122	127	132	137	142	147
103	108	113	118	123	128	133	138	143	148
104	109	114	119	124	129	134	139	144	149
105	110	115	120	125	130	135	140	145	150

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3	10	17	24	31	38	45	52	59	66	73	80	87	94	
4	11	18	25	32	39	46	53	60	67	74	81	88	95	
5	12	19	26	33	40	47	54	61	68	75	82	89	96	
6	13	20	27	34	41	48	55	62	69	76	83	90	97	
7	14	21	28	35	42	49	56	63	70	77	84	91	98	

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101	106	111	116	121	126	131	136	141	146
102	107	112	117	122	127	132	137	142	147
103	108	113	118	123	128	133	138	143	148
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Publisher's Postscript...

ATOM-POWERED BOTTLES

It used to be that publishing a technical magazine was like sealing thousands of messages in thousands of bottles and strewing them on an indifferent sea. Sometimes years would pass before we'd get a response. Sometimes we never would.

Today those bottles have become atom-powered. Your letters and cards are in the mail to us the same day you receive the issue. By the time a week has passed, our Reader Service Manager is up to her pretty knees in requests for more information.

Editors like to think their golden words have brought about this change. It's true that better-written articles, revolutionary developments reported within days, the faster pace of technical progress mirrored in our pages—all have made for a more exciting publication. But ads are better written—and engineers have changed, too. They're more responsible—hence more responsive to the world around them.

Advertisers feel their responsibilities as well. Some have always followed the lead of the editors, picking up the editing style professionally designed to catch and hold the reader's attention.

But there is more to it than that—emphasis on style ignores the most important factor—content. If an advertisement offers the reader no new information, no worthwhile data, it makes no impression whatever on him, and certainly gets no requests for more information.

Seems obvious? Well, it takes the combined efforts of publisher, advertiser, and reader through exhaustive surveys of reader reaction (the first in our field) to *every ad* and *every editorial* item to prove the case in the face of the tell-them-how-good-I-am philosophy. As one skilled advertising man has said, "There's still too much 'me' and not enough 'you' in technical advertising."

There's still plenty of room for improvement. We certainly don't know all the answers, but you do—and you can tell us if you will take the time to think about it.

What would you like to see in an advertisement? Which do you consider good examples—which are a waste of space?

Can you, in one sentence, define the ideal advertisement? Write it on the card on this page and send it in. We'll print the best ones in this column over the senders' names.

—SJA

Issue of August 24, 1959
Product Engineering
Card Expires October 23, 1959

FIRST CLASS
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NEW YORK, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid By Reader Service Department

PRODUCT ENGINEERING
330 WEST 42ND STREET
NEW YORK 36, N. Y.

★ *If you want to be sure of seeing every issue of Produce Engineering—52 regular issues plus the annual Design Digest—enter your subscription on the attached information card. Only $5 for one year.*

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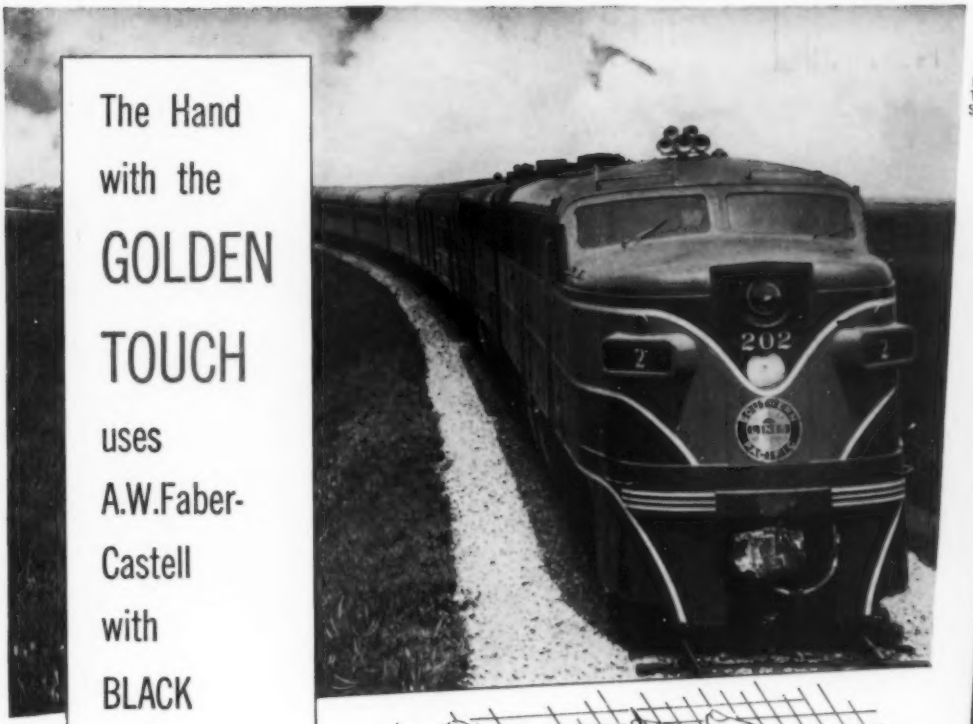
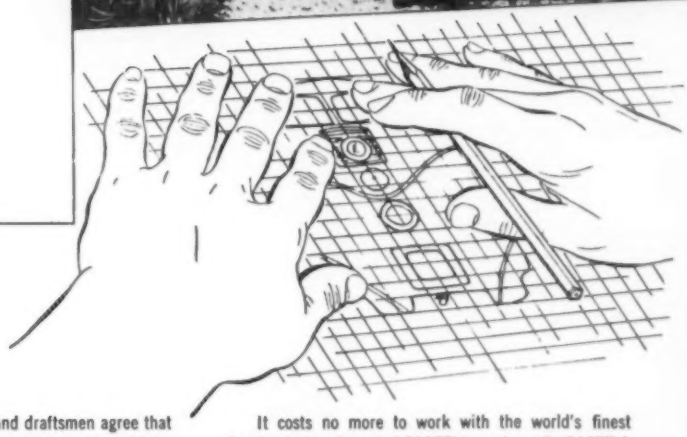
PRODUCT ENGINEERING
330 WEST 42ND STREET
NEW YORK 36, N. Y.

The Hand with the GOLDEN TOUCH uses A.W.Faber-Castell with BLACK GOLD Graphite



"Sunset"
Photo courtesy of
The Budd Co. and
Southern Pacific Railroad.



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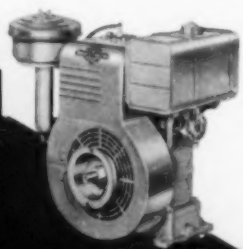

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